UNIVERSITY OF AGRICULTURAL SCIENCES

BANGALORE

This book is presented to Mr.Desmond Mascarenhas, studying in I B.Sc.(Ag.) for standing FIRST in Debate Competition in English,organised by the University of Agricultural Sciences, Bangalore, in connection with the Celebration of International Education Year, 1970.

K.C. Naik

Oct.24, 1970 Vice-Chancellor.

FRUITS

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INDIA—THE LAND AND PEOPLE

FRUITS

RANJIT SINGH

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New Delhi

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FOREWORD

THIS BOOK IS another valuable addition to the series "India—the Land and People" which the National Book Trust has planned. The aim of this project is to provide knowledge about all aspects of our country to ordinary readers in simple and non-technical language.

Fruits have a universal appeal, both to the palate and to the eye, and they constitute an important part of our diet. A number of books on this interesting subject are no doubt available but their highly technical or regional nature limits their usefulness.

Prof. Ranjit Singh, in writing this book, has avoided these limitations and set forth in clear, simple language what a common reader ought to know about raising fruit trees, their care and their protection from pests and diseases.

I hope this book will help arouse interest generally in the rich variety of the fruits of India and their scientific cultivation, so that the diet of the average man may be made more fruit-oriented and vitamin-rich.

NEW DELHI
March 25, 1969

B. V. KESKAR

PREFACE

It is surprising how little we know about the variety of fruits grown in our own country. The wide range of climatic conditions found in India makes it possible to grow an array of fruits. In North India fruits like mangosteen, rambutan and durian are unknown. In the extreme South, hardly anyone is familiar with apricots, quince, strawberry or raspberry. One of the objects of this book is to bring out the rich variety of fruits found in India, their beauty and their nutritive value. It is also interesting to note how many of our common fruits have been introduced from other countries in comparatively recent times. Such is the case with guava, papaya, pineapple and sapota.

The second object of this book is to give hints on the cultivation of these fruits in different parts of India. It is difficult to serve the interests of all types of readers—both technical and non-technical—in a single volume. In dealing with the cultural aspects of fruits, the details of the various operations have, therefore, not been included. Only the peculiarities of each fruit and the important regional aspects have been highlighted. It is assumed that the fruit-grower is familiar with the basic techniques of horticulture, such as inarching of a mango plant, pruning and training of an apple tree, and budding of an orange tree. A comprehensive list of the wild and cultivated fruits found in India, their scientific and regional names and their habitats, as well as the nutritive value of different fruits have been given in appendices at the end of the book.

Any book of this type draws on the knowledge accumulated up to the present time and cannot help repeating information published previously. I have freely drawn upon past literature. *The Mango* by L. B. Singh was an excellent source of information on this fruit. *Fruit Growing in India* written by W. B. Hayes was helpful for the historical aspects and for the conditions prevailing in North India. *South Indian Fruits and Their Culture* by K. C. Naik, *Horticulture in the Hill Regions of North India* by A. R. Thapar and *Commercial Fruits of India* by G. S. Cheema, S. S. Bhatt and K. C. Naik were useful sources of information on other regions of India. *The Wealth of India*, published by the C.S.I.R., was useful in regard to the botanical nomenclature of most plants. I also drew on the experience of several friends concerning problems of different regions. The eagerness with which they were prepared to share their knowledge was indeed gratifying.

It is with more than mere formality that I thank Dr. B. P. Pal for the inspiration he gave me in writing this book. I am also grateful to Dr. M. S. Swaminathan and Dr. S. K. Mukherjee for their encouragement in this undertaking. I am thankful to Mr. V. C. Lele for going through the portions dealing with plant diseases and Mr. K. M. Peswani for going through the portions concerning the insect pests of fruit crops.

The Indian Council of Agricultural Research is to be thanked for the loan of blocks and photographs used in this book and also for permission to use the appendix about the nutritive value of fruits from their publication, *Fruit Culture in India*.

NEW DELHI
March 1969

RANJIT SINGH

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(*Cover illustration by courtesy:* Processed Foods Export Promotion Council, New Delhi)

CHAPTER

HISTORY AND SCOPE OF FRUIT CULTURE

FRUITS ARE undoubtedly man's oldest food. The history of fruits is as old as that of Adam, Eve and the forbidden apple. Before the start of organised agriculture, the prehistoric nomads lived on wild game, wild fruits and berries. When man took to organised agriculture, he cultivated grain crops, but undoubtedly he grew some fruits in his backyard.

There are many references to fruits in ancient literature. The earliest fruit cultivated by man seems to be the date-palm, which has been mentioned in records of long ago as 7,000 B.C. Pomegranate is also one of the oldest fruits brought under cultivation. It has been mentioned in records dating back to 3,500 B.C. Fig and olive have been the popular fruits of Egypt and the neighbouring areas since time immemorial. Grapes, fig and olive have been mentioned in the Old Testament, which was written around 1,000 B.C. The *Bible* gives directions on wine-making, and so do the records of the Fourth Egyptian Dynasty written in about 2,440 B.C. References to peach, which originated in China, and almond are found in Egyptian manuscripts written in about 1,300 B.C. The book of Confucius, which was written in 1,000 B.C. in China, also refers to the peach. There is no doubt that man has been interested in fruits from very early times.

The techniques of fruit culture and fruit utilisation also received the attention of man at a very early stage. Accounts of the different systems of training grape-vines, methods of propagation by seeds, cuttings, grafts and inarching, making of wine and preservation of fruits in oil and salt are found in records of the pre-Christian era. The first book in the world on fruit culture is believed to be the one on litchi written in the year 1056 A.D.

In India also the cultivation of fruits dates back to ancient times. Fruits have figured prominently in the life of India. In the fourth century B.C. and even in the pre-Buddhist period, horticulture was an important avocation in India. A reference to land suitable for grape cultivation has been made in the *Arthashastra*, believed to have been written in the fourth century B.C. Mango, banana, fig, grape and date were the favourite fruits of that era. Mango seems to have been under cultivation for more than 4,000 years. The presence of mango in the carvings in the Buddhist stupa at Sanchi and the fact that fruits like banana, coconut and mango figure in offerings to gods and in our rituals points to the antiquity of fruits in India. The fact that mango and banana leaves are traditionally used to decorate doors and gateways on festive occasions speaks of their importance and the esteem in which they have been held. Mention of vegetative propagation by cuttings and grafting of many fruits, including jack-fruit, dates back to the period 1,200 to 200 B.C. Other fruits mentioned in this era are *aonla*, wood apple and tamarind.

Many delicious fruits are indigenous to India, but many more have been introduced from foreign lands. Mango, banana, *phalsa*, jack-fruit, *bael*, *aonla* and some citrus fruits like lemons and citrons seem to be indigenous to India. However, there is some doubt in the case of mango and banana. If mango is an introduction, it must have come to India at a very early stage. No country can compete with India in the rich variety of mangoes which have developed here. Litchi, loquat, persimmon, peach, and sweet orange have come from China. Some of the common fruits, which we take for granted in this country, have been introduced from the tropical parts of America, probably by Portuguese settlers. These include guava, papaya, sapota or *chikoo*, custard-apple and pineapple. Apple, pear, plum, cherry, almond, apricot, walnut, grape, pomegranate and pistachio-nut have been introduced from the Central Asiatic regions. The fact that so many of our important fruits have been introduced from abroad is no more surprising than the fact that even common crops like maize, potato, tobacco, groundnut and tomato are also introductions into this land.

Hiuen Tsiang, the Chinese Buddhist pilgrim, who came to India in 629 A.D., noted the presence of mango, pomegranate and sweet orange everywhere. He also saw banana, *ber*, grapes, pear, peach, plum, apricot, *aonla*, *Ficus glomerata*, jack-fruit, *Diospysos* sp., and wood-apple. He noted that loquat, which is native to his country, was not present.

Early medical works in Sanskrit, the *Charaka Samhita* and the *Sushruta Samhita*, also mention fruits like *aonla*, *bael*, citron, wild dates, wild fig, grapes, hog plum, jack-fruit, monkey-jack, *jaman*, *ber*, *karonda*, *khirni*, lemon, lime, mango, mulberry, orange, sour orange, *phalsa*, banana, pomegranate, walnut, almond, pistachio-nut and wood-apple. *Vriksha Ayurveda*, composed in 1392, deals with fruit culture and propagation, including graftage. Emperor Babar was the first to record in his memoirs in the early sixteenth century the presence of some citrus fruits. He has mentioned the citron, sour orange, *sangtra*, lime, *jambhiri*, *kilkil* (galgal), *sadaphal*, *karna* and the *amilbed*, which he said was so sour that it would dissolve a needle inserted into it! Towards the end of the sixteenth century, about 100 years after the discovery of America, the presence of pineapple and custard-apple, indigenous to the New World, were reported in *Ain-i-Akbari*, the record of the reign of the Moghul Emperor Akbar. The guava was reported to be present in India a few years later. The pineapple and papaya were probably introduced into India by the Portuguese, the latter by way of the Philippines. *Rambutan*, durian and mangosteen, which are tropical fruits, were reported to be present in India about the same time. Along with pineapple the cashew also came from Brazil. The presence of strawberry and bread-fruit in India was reported in 1798 by Pennat. *Phalsa* (*Grewia subinaequalis* or *G. asiatica*), though indigenous to India, was first reported to be present in India as late as 1793 by That Ives. It is of interest to note that the important fruits of India, like mango, banana, citrus fruits, guava and papaya are all evergreen. None of the deciduous fruits like apple, pear and grapes, which shed their leaves in the cold season, formed the basis of commercial cultivation of fruits. Only in recent times has apple cultivation gained importance.

Even though fruits have been cultivated in India for a very long time, their commercial cultivation as an industry is still in its infancy. In the past, fruits were cultivated as backyard plants or as border trees along fields to meet the needs of the family. Mango, mulberry, *jaman*, *ber*, or guava trees growing by the side of a Persian wheel or a temple are a familiar sight. Where regular plantations of fruit trees existed, their area was very small. Neglect of the fruit trees was a characteristic feature of our fruit culture. There seemed to be a belief that since fruits are woody perennial trees, they do not require any care and should grow in spite of neglect, as is the case with wild trees like acacia, banyan and *sisoo* or *shisham*. Soil which was considered unsuitable for the cultivation of field crops was utilised for fruit-growing. Irrigation and manuring of trees was neglected after the first few years. The trees were planted too thickly and plant protection measures to control diseases and insect pests were unknown. Pruning of the crowns of the plants was unknown. In fact, the gardeners of the olden days were loathe to cut any part of a tree. However, they resorted to some weird practices like adding salt to the roots of mango trees in the coastal area of Ratnagiri, in the south of Bombay, and powdered bricks to the soil to improve the colour of pomegranate and hammering the trunks of mango-trees to induce fruitfulness. Root-pruning to induce flowering has also been a common practice. Yield of fruits under these conditions was low, as was only to be expected.

Another aspect of orcharding at this stage was that it was the hobby of the aristocracy, who took pride in collecting a large number of varieties and vied with one another in this. Many of the plants collected were seedlings. This was particularly true of mango collections. The "Lakh Bagh" in Bihar, which was supposed to contain one lakh (100,000) varieties, was the epitome of this craze during the Moghul period. These varied collections were no doubt rich in variety of fruit types, but they contained a preponderance of unproductive trees. These orchards were, therefore, poor commercial propositions. Most of the varieties had fruits of poor keeping quality. The apple variety *Ambri* grown in Kashmir is a notable exception to this. Modern fruit industry lays great emphasis on the transport and keeping quality of the fruit. The need for culling a large number of uneconomic varieties has now been fully realised.

In the nineteenth century, several European settlers and missionaries did pioneering work in introducing new varieties from the U.K., France, and the East Indies, and establishing commercial orchards. The names of Lee in the Kulu Valley and Coutts and Stokes in the Simla Hills are noteworthy. In South India several missionaries introduced some citrus fruits and grapes. As stated earlier, the Portuguese also played a role in introducing new kinds of fruits from other lands. Subsequently, introductions were also made from Japan, Australia and the United States. The foreign settlers set a fine example of commercial orcharding. A unique post parcel trade in the supply of apples developed in Kulu as a result of this. Even now the Kulu Valley supplies apples by post to far-away places like Nepal.

The development of fruit-growing on commercial lines has taken place only during the past quarter century. The statistics on fruit culture are not very reliable. There are many scattered and roadside trees of mangoes which are hard to survey. According to the latest figures available, the area under fruits in India is about three million acres, which represents about 0.8 per cent of the total cultivated area. As compared to this, the area under vegetables is 3.1 million acres. Most of the area under fruits is under mango, which constitutes over 50 per cent of the total area. The next important fruit is banana, followed by citrus. The area under different fruits in India is given in the following table.

AREA UNDER DIFFERENT FRUITS IN INDIA

	(in million acres)		*(in million acres)*
Mango	1.326	Pome fruits	.024
Banana	.464	Grape	.007
Citrus	.225	Cashewnut	.479
Guava	.145	Other fruits	.408
Papaya	.015		
		Total	3.093

Earlier, in 1955, the Indian Council of Agricultural Research had collected the figures of areas under fruits which are given below:

	(in million acres)		*(in million acres)*
Mango	1.4594	Jack-fruit	.1644
Banana	.3707	Ber	.0244
Citrus	.2233	Grapes	.0016
Guava	.0685	Sapota	.0008
Papaya	.0216	Pomegranate	.0019
Temperate fruits	.0401	Figs	.0007
Custard-apple	.1101	Dates	.0008
Cashewnut	.1573	Phalsa	.0002
Litchi	.0239	Other fruits	.1127
Pineapple	.0213		
		Total:	2.8037

According to these figures, the area under mango, citrus and papaya shows a slight decrease during this period. The area under banana, guava, grapes and apple has undoubtedly increased during the recent past. The late Mr. W. B. Hayes had reported in a book a total area of 3.4 million acres under fruits in India in 1955. His Stateswise figures (adjusted according to the reorganised States of India) and the latest available figures are given in the table on the following page.

These two sets of figures suggest that the total area under fruits in India has decreased during the last few years. The decrease in the case of U.P. and West Bengal is striking. On the other hand, Andhra Pradesh and Orissa show a marked increase. This, however, does not represent the correct picture. The area has actually been constantly on the increase. Several factors are responsible for complicating the issue. The area under short-duration crops like banana, papaya and pineapple is constantly changing. Several crops like jack-fruit and custard-apple consist mostly of semi-wild trees and the estimation of their area is subjective. Mango and cashew are often planted as stray trees and the estimation of their area is also difficult. Some statistics include coconut and cashew under fruits and others do not.

AREA UNDER FRUITS IN INDIA

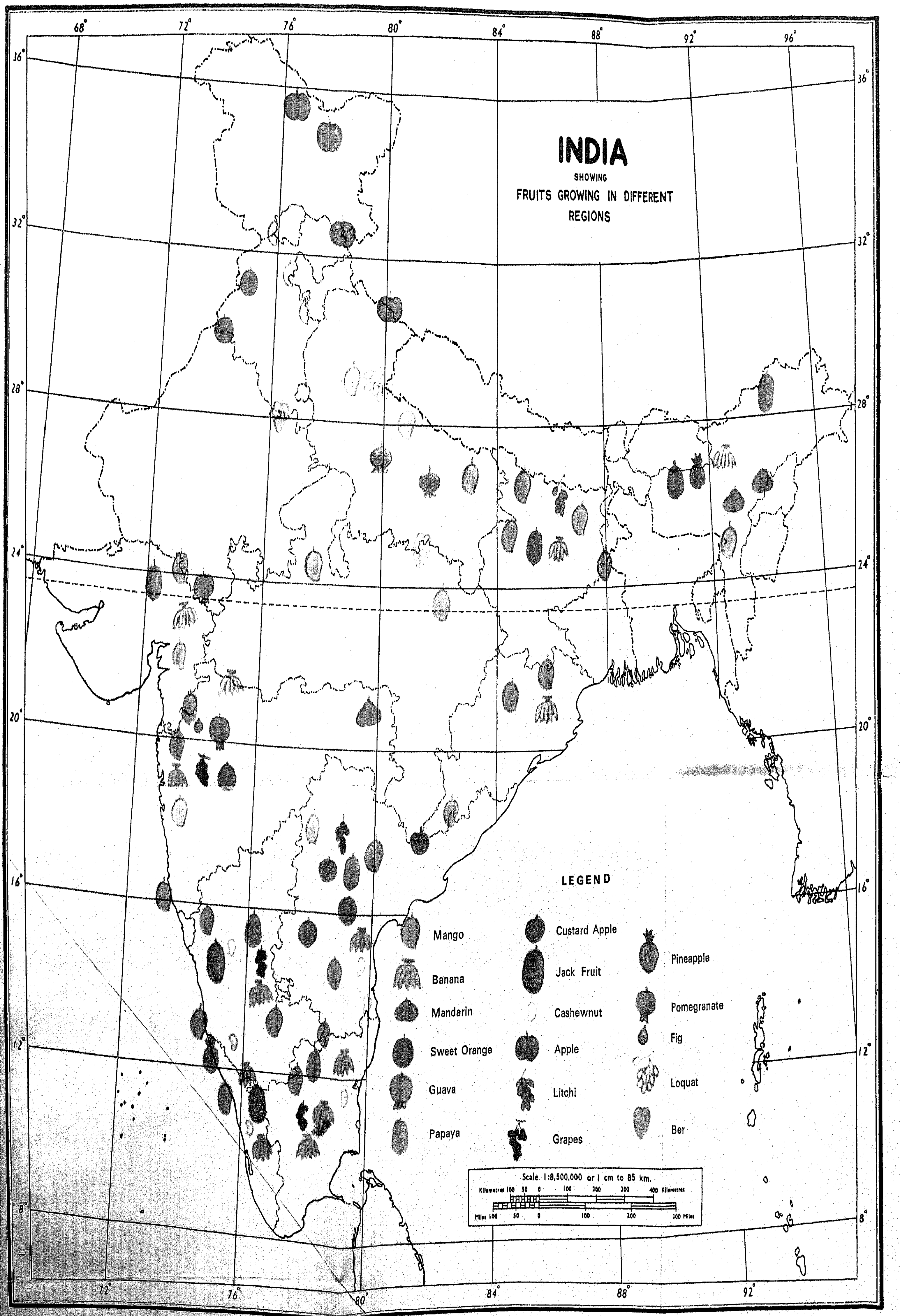
State	*1955 (Hayes)*	*Current*	
	acres		acres
U.P.	1,458,890	U.P.	260,000
Bihar	329,400	Bihar	383,000
Andhra Pradesh	268,284	Andhra Pradesh	465,000
Madras (including Malabar)	346,008	Madras (excluding Malabar)	303,000
Travancore-Cochin	61,512	Kerala	420,000*
West Bengal	213,715	West Bengal	30,000
		Tripura	63,000
Orissa	172,799	Orissa	205,000
Gujarat & Maharashtra (except Vidarbha)	139,781	Gujarat	95,000
		Maharashtra (including Vidarbha)	183,000
Madhya Pradesh & Vidarbha	117,513	Madhya Pradesh (excluding Vidarbha)	103,000
Assam	111,390	Assam	133,000
Mysore & Coorg	95,646	Mysore (including Coorg)	165,000
Punjab, Pepsu & H.P.	64,647	Punjab & Haryana	65,000
		Himachal Pradesh	10,000
Kashmir	18,500	Jammu & Kashmir	20,000
Ajmer	1,821	Goa, Daman & Diu	103,000
Andaman Islands	385	Andaman Islands	1,000
Total	3,400,531	Total	3,093,000

*Excluding coconut.

Most of the fruit culture in India is confined to the submontane areas along the Himalayas and south of Bombay and Hyderabad except for the cultivation of mandarin oranges in a few districts around Nagpur. The central part of India does not have much of a fruit industry.

The production of fresh fruit from this area is variously estimated at 6.8 to 10 million tons. The losses in handling, transport and marketing are high, being as much as 10 per cent. The consumption of fruit per head, therefore, comes to about half an ounce per day. This is about one-fourth the amount required for a healthy diet. In the United States, the consumption of fruits and vegetables per head per day is about one pound. The deficiency of fruit in our diet becomes all the more alarming when we consider the fact that most of the fruit is consumed by the affluent classes living in the cities. The rural population, which has a low buying power, gets hardly any fruit, except perhaps a few sucking mangoes in the season. There is need to increase the area under fruits to more than double the present level.

Even at the present time, the yield of fruits in most cases remains low and the prices are high. Fruits are, therefore, not within the means of the working classes. Only in the case of grapes and apples are the orchards managed efficiently and the yields are high, being up to 20 tons per acre in the case of grapes and 10 tons in that of apples. Banana plantations are managed efficiently in areas like East Khandesh, but in Assam bananas are grown mostly as a backyard crop. Grading of fruits for marketing is hardly done. During the Second World War grading of sweet oranges in Andhra Pradesh and of mangoes in Bihar was started, but it has petered out. The packing of the fruit also leaves much to be desired. In the past, mangoes shipped from the south to Delhi have been dumped loose into railway wagons. Often bamboo baskets are used for packing the fruits. They fail to protect the fruit properly. As pointed out earlier, the consequent losses in handling of fruit have been as high as 10 per cent. Lack of refrigerated transport has also been a bottleneck in the development of the fruit industry. Road transport has been gradually improving and the fruit industry


INDIA
SHOWING
FRUITS GROWING IN DIFFERENT REGIONS
LEGEND
Mango
Banana
Mandarin
Sweet Orange
Guava
Papaya
Custard Apple
Jack Fruit
Cashewnut
Apple
Litchi
Grapes
Pineapple
Pomegranate
Fig
Loquat
Ber
Scale 1:8,500,000 or 1 cm to 85 km.
Kilometres 100 50 0 100 200 300 400 Kilometres
Miles 100 50 0 100 200 300 Miles
68° 72° 76° 80° 84° 88° 92° 96°
36° 32° 28° 24° 20° 16° 12° 8°

The demarcation of the Gujarat-West Pakistan boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968) has consequently been greatly stimulated. This is particularly true of hill regions like Kotgarh and Kulu in Himachal Pradesh, where the possibility of expanding apple cultivation after the establishment of dependable road transport in all seasons has pushed the price of land as high as Rs. 10,000 per acre.

During the recent past, the various States have taken several measures to encourage fruit production. The Kashmir Government at one stage is said to have supplied fruit plants free to growers. In the undivided Punjab, before the creation of Pakistan, an extra supply of canal irrigation was made available for raising orchards. After the creation of Pakistan, the Punjab Government set apart 13,000 acres of land for establishing garden colonies of 500 to 1500 acres each. These were intended to be run along with service co-operatives. The idea, however, did not succeed. The greatest impetus to fruit-growing was given by the fact that orchards were in most cases exempt from the ceiling on land under the land reform laws. Another factor which has attracted the affluent class from the cities to the cultivation of grapes and apples is the fact that there is no income-tax on agricultural earnings.

The area under fruit cultivation on scientific lines has been increasing in spite of some set-backs to fruit-growing due to hazards of citrus decline, mango malformation and erratic bearing of mango. Whereas old neglected orchards have been vanishing, new ones managed on scientific lines have been coming up. As will be seen from the figures presented earlier, the overall area under fruits has not increased. The acute shortage of cereals in the country during the last few years has prevented the Government from giving more incentives for the cultivation of fruits. The total fruit production in the country thus remains far too inadequate.

We have been importing substantial quantities of fresh and dry fruits. This includes dates from Arabia, grapes and raisins from Afghanistan, apples from the U.S.S.R. and Australia, grapes from Spain and almonds, pistachio and dried figs, etc. The figures for import and export are given in the following table.

IMPORT AND EXPORT OF FRUITS, NUTS AND VEGETABLES, ETC., FROM INDIA*

	EXPORTS		IMPORTS	
Cashewnut	Rs. 430,288,891	(51,040,572 kg)	Rs. 250,836,871	(168,218 tonnes)
Almond (nuts)			Rs. 26,745,674	(4,244,290 kg)
Total of nuts (Inc. cashew)			Rs. 282,029,342	(172,990,540 kg)
Banana	Rs. 2,028,058	(3,878,287 kg)		
Mango	Rs. 1,819,334	(1,074,723 kg)	Rs. 12,153	(30,040 kg)
Citrus fruits	Rs. 571,375	(303,323 kg)	Rs. 189,185	(366,803 kg)
Grapes	Rs. 8,092	(3,431 kg)	Rs. 27,928,250	(18, 656,519 kg)
Pomegranate			Rs. 7,743,669	(4,562,865 kg)
Apples	Rs. 43,486	(14,653 kg)		
Total fresh fruits (Except nuts)			Rs. 35,466,154	
Total fresh fruits & nuts	Rs. 450,639,370			
Dates (dried)			Rs. 33,375,513	(53,059,194 kg)
Raisins			Rs. 34,433,978	(10,334,176 kg)
Figs (dried)			Rs. 678,725	(180,790 kg)
Apricots, plums prunes, etc. (dried)			Rs. 890,767	(291,300 kg)
Total dried fruits	1,415,011	(Mostly dried mango slices)	Rs. 70,213,663	(63,931,425 kg)
Preserved fruits	10,140,511		Rs. 16,920	(295 kg)
Other products	7,934,319	(Including mango chutney and mushrooms)		
Total fresh Vegetables	45,904,157		Rs. 4,718,509	(Inc. hops and apricot kernels)

*Based upon "Monthly Statistics of the Foreign Trade of India". Figures for the year ending March, 1968.

It will be seen from the foregoing table that the import as well as export of fruits and nuts from this country is substantial. However, about 75 per cent of the import consists of cashewnut, which is re-exported from India after processing. Excluding cashewnut, India imports under thirty-six million rupees worth of fresh fruits and seventy million rupees worth of dried fruits, mostly comprising dates. Against this, our exports are twenty million rupees worth of fresh fruits and 1.4 million rupees worth of dried fruits. The imports thus exceed the exports by seventy-eight million rupees. Our major exports consist of banana, mango, and oranges to Bahrein, Kuwait, Nepal, Lebanon, Europe and some fruits to Indonesia. In recent years, renewed efforts have been made to step up the export of banana to the U.S.S.R. and Switzerland, and of mango to the U.K., the U.S.S.R., France, Germany, the Netherlands, Sweden, Italy, and Hong Kong, but the volume of export still remains small and can be greatly increased. In the case of banana, even the limited export seems to have contributed recently to the increase in its price in the domestic market. The need for increased fruit production is, therefore, apparent.

It has now been realized that fruits should no longer be considered a luxury, since they are protective foods necessary for the maintenance of human health. Furthermore, fruits like banana and dates are also a rich source of energy-giving carbohydrates. Whereas an average crop of wheat will give 1,034,880 calories per acre, papaya with a yield of over 40 tons per acre will give 18,923,520 calories and banana with a yield of 10 tons per acre will give 15,052,800 calories. The corresponding figures for mango are 2,688,800 and for guava 1,511,532. Walnut, avocado (*Persea drymmifolia*) and almond are good sources of protein and fats. Apart from their high energy-giving carbohydrate content, fruits are more valuable for the minerals, vitamins and enzymes which they provide for better functioning of the human body and for fighting diseases. This fact is more important for a country like India, where the majority of the population is vegetarian.

Several vitamins are found in different fruits. Vitamin A, which gives resistance to diseases, prevents night-blindness and promotes growth in young age, is found abundantly in mango, papaya and persimmon. It is also plentiful in dates, jack-fruit, and walnut. Vitamin B, the lack of which causes beriberi, paralysis and loss of sensitivity of skin, etc., is most abundant in cashewnut, walnut and almond. It is also plentiful in banana and dried apricot. Vitamin B_2 (riboflavin) is required for the growth and health of the skin. Its deficiency causes loss of weight, lack of appetite, sore throat and cataract. It is most abundant in *bael* and is also plentiful in papaya, cashewnut, litchi, pineapple and pomegranate. Vitamin C, the absence of which causes scurvy, is most plentiful in Barbados cherry (*Malphigia glabra*). *Aonla* (*Emblica officinalis*) and guava are also very rich in it. Other good sources of this vitamin are citrus fruits, tomato, *bael* (*Aegle marmelos*), mango, jujube and papaya. The citrus fruits along with vitamin C contain vitamin P, without which our very small blood vessels may start bleeding. It also helps in the assimilation of vitamin C. The vitamin content of the fruits may vary according to the stage of maturity, storage temperature, the nutrition of the tree, especially nitrogen, and exposure of fruit to light. Almond, dried apricot, *karonda*, walnut, cashewnut, avocado, *bael*, raisins, and dates are good sources of mineral matter. Among these, *karonda* is the richest source of iron and is followed by dates. Papaya also contains a protein-digesting enzyme, which resembles pepsin. The importance of these fruits in the human diet needs no further emphasis.

Cultivation of fruits is a highly remunerative enterprise. A good apple orchard can give an annual income of Rs. 10,000 to Rs. 15,000 per acre. In fact, there are examples of a family subsisting on as little as one-fifth of an acre. Similarly from grape cultivation in Hyderabad and South India, where yields upto 20 tons per acre are obtained, a gross income of Rs. 25,000 per acre can be expected from a good vineyard. It is noteworthy that fruits which comprise 0.8 per cent of the cultivated area in India constitute over seven per cent of the crop wealth. The necessity and scope for expanding the fruit industry in India and its profitability are evident.

India is a vast country with a variety of climates, where all types of fruits can be grown. In the Himalayas the temperate fruits can be grown most successfully from Kashmir to the hills of U.P. The eastern region of the Himalayas above Assam, Bengal and Bihar is too wet. Heavy rainfall and high humidity in this area are conducive to the occurrence of diseases of fruit trees. In the Western Himalayas fruit cultivation is limited to hail-free areas. Apples, walnuts, and cherries are cultivated at elevations above about 6,000 feet, except in the Kashmir Valley, the altitude of which is about 5,000 feet. Pears and persimmons grow at slightly lower altitudes. Plums, apricots and peaches are cultivated at elevations of from 4,000 to 5,000 feet. Some temperate fruits are grown on the hills in South India. Varieties of plums and peaches with low chilling requirements are also grown in the submontane areas. Mango is found growing all over India, up to an altitude of 4,000 feet, but it does not fruit well above 2,000 feet. Banana is grown principally in the South and East. Citrus fruits grow in most parts of the country, except at high elevations. Guava is common in U.P. and Bihar, and papaya in all frost-free areas. Grapes can be grown in most places, except at very high altitudes and in wet and humid areas. Litchi and loquat can be grown in the sub-tropical submontane areas. At the foot of the Nilgiri Hills in South India, several exotic fruits have been grown successfully. These include mangosteen, durian, avocado and *rambutan*. *Ber* can be grown anywhere in the plains and the date-palm can be cultivated in the dry desert areas. Other fruits successful in India include *phalsa* (*Grewia subinaequalis*), pomegranate, fig, pineapple, custard-apple, *jaman* (*Syzygium-cuminii*), jack-fruit, *sapota* (*Acharas zapota*), cape gooseberry, mulberry, passion fruit, *aonla* (*Emblica officinalis*) and tree tomato (*Cyphomandra betacea*).

The variety of climates and the different types of fruits which can be grown in India are indeed impressive. However, the climate in some places is very rigorous and only very hardy varieties can thrive. For example, in the plains of North India the climate is not really sub-tropical, but semi-tropical. The fruit trees being perennials remain in the field all through the year and they must successfully withstand the desiccating hot weather in May and

June, frequent frosts during winter and water-logged conditions along with the incidence of all kinds of diseases and insect pests during the monsoon season. Failure to withstand any of these conditions will result in the death of the plants. Annual crops have the advantage that they can complete their life-cycle in the favourable period of a few months confined to one season.

Fruits are available in India almost all through the year. An almost unlimited number of varieties with different flavours is available. Mango starts ripening in Cape Comorin in January. As we go north the ripening becomes later. Some varieties in U.P. and the Punjab ripen in August. Citrus fruits ripen from August to April in different parts of India. In Central and South India in the same locality there are two or three crops of citrus. Banana ripens from September to April. Loquat comes to the market in April and litchi and mulberry in May. Cherries, peaches, plums and apricots ripen from May to July. Pears come to the market from August to September and apples up to November. A variety of fresh fruits is, therefore, available all through the year. The scope for growing a variety of luscious fruits of different types is, thus, unlimited.

The question arises as to why the development of fruit industry has been slow in our country of vegetarianism in spite of the large variety of fruits which can be grown here, the need for greater production of fruits and the high economic returns which can be obtained from them. The answer lies in the fact that fruit-growing is a long-term venture requiring a high initial investment and a high recurring expenditure. Most of the fruit trees are woody perennials with deep roots which take several years to bear fruit. They require intensive cultivation, including specialised methods of propagation, use of root-stocks, and heavy irrigation. The product is perishable and needs careful transport, handling, and marketing. The ordinary farmer in India is poor and is unable to muster the high investment required. The low purchasing power of the consumer has also been a hindrance in the expansion of the fruit industry.

With industrialisation, economic growth of the country, and development of better road transport, fruit-growing is bound to expand. The fruit preservation industry will also grow and increase the demand for fruits. Fruit cultivation, therefore, has a bright future. With our rapidly increasing population, the pressure on land is likely to continue and the size of the holdings will remain small in the foreseeable future. This requires intensive agriculture, giving maximum output of food per acre. Fruit culture can meet these requirements amply. The area under fruits can safely be more than doubled to constitute two per cent of the total cultivated area. With a higher production per acre, even if the price of fruits comes down to half the present level, the fruit-grower will still make a reasonable profit.

The marketing of fruits in India is the most sorry aspect of the fruit industry. Whereas in countires like Japan, the small growers are assured of an adequate price for their produce through co-operative marketing, the grower in India is at the mercy of the middlemen, who make more profit than the growers. The standing crop is generally sold to a contractor when the fruit is still immature. The contractor looks after the crop, protects it from bird attack and sells it in the wholesale market, where the commission agents, brokers and retailers take a heavy slice of the profit. The number of middlemen is unnecessarily large. The contractors often harvest the crop too soon, in order to save the expenses on watch and ward and to avoid losses due to fruit-drop, etc. This results in low prices for the produce.

If the grower tries to market the fruits himself, he does not do any better. He is obliged to send the fruit to distant markets and has to rely on the commission agent to safeguard his interests in disposing of the fruit. The buyers are a closely-knit group in the market, whereas the growers are scattered in different parts and are unaware of the market trends. The grower thus gets less than a fair deal and has to accept whatever price the commission agent sends him. There is, therefore, a strong need for developing the co-operative system of marketing and cold storage.

CHAPTER II

MANGO

MANGO undoubtedly deserves to be the national fruit of India. In area, production, nutritive value and popularity of appeal, no other fruit can compete with it. It occupies the same position in India as is occupied by the apple in temperate climates and grapes in sub-tropical areas. It is the favourite fruit of all parts of India and has been repeatedly acclaimed as the "king of fruits". The Moghul Emperor Babar called it the choicest fruit of Hindustan. The paisley design, which is a dominant design in our hand-printed fabrics, represents a mango fruit and is considered to be a symbol of India in foreign countries. The fruit is well-liked in countries to which it is being exported. However, people who have been exposed to it since childhood seem to enjoy it much more. Some of the early European visitors to India have made uncomplimentary remarks about the mango. This is partly due to the strong turpenous aroma and fibrous texture of some of the common varieties and mostly due to their own prejudice. Who can resist mango fruits of optimum ripeness of varieties like Dasheri and Alphonso?

The mango is one of the most ancient fruits of India. It was established in India in the pre-Christian era. Its cultivation in India is estimated at more than 4,000 to 6,000 years old. In the *Ramayana* and the *Mahabharata* forests and gardens of mango have been mentioned. It has been held in high esteem by the Hindus. Its blossoms are used for the worship of the goddess Saraswati and festoons of mango leaves are strung over doorways on auspicious occasions. The mango has exercised a great spell on the Indian mind through the ages and the tree has been described as *Kalpavriksha* or the wish-granting tree. Its common vernacular name *Aam* means 'the common'. It is not only common throughout India, but is also the fruit of the common people. Its name *Amra* used in Sanskrit literature has been used as a suffix to mark

distinction and adoration for people and things. Kalidasa named a mountain as *Amrakuta* in his great Sanskrit epic, the *Meghadoot*. The grammarian Panini used the name Amragupta for men and Amrapura for towns. A king named Amrapala and a courtesan named Amrapali are historical characters. Names like Amragandhaka, Amranisa and Amragandhiharitra have been given to plants to give them prestige. The temple of Kanchi bears testimony to the religious glorification of the mango in ancient times. In Saivist literature the *Linga* has been called the *Amra-takeswara*.

The mango enjoyed a pre-eminence even in the Vedic ages, as has been recorded in the *Satapatha Brahmana*. The verses of the great *Ramayana* written by Valmiki are full of love for the mango. Many a folk-song refers to the torture that the fragrance of the mango flowers causes to love-lorn hearts. Poet Kalidasa has called the mango-blossom one of the darts of *Manmatha*, the Hindu god of love. The *Amar Kosh* written in the Buddhist times by Amar Sinha contains an immortal eulogy of this luscious fruit. It has also created a place for itself in the Indian art. Sculptures of the mango tree and its fruit are found in the Buddhist stupa at Sanchi, which dates back to about 150 B.C.

Mango is found in several other countries but in no other country does it enjoy the status it does in India. India is the only country where truly wild forests of mango are found in Assam and the adjoining Chittagong Hills. No other country can surpass India in the number of mango varieties and the richness of their flavours. The climate of India is ideally suited to its cultivation and it is found growing in every nook and corner of the country except at altitudes above 3,000 feet. The tree assumes enormous proportions under ideal conditions. A classic example is the *Chhappar* tree in village Burail near Chandigarh in the Punjab. This tree has a trunk with a girth of 32 feet and branches up to 80 feet long and 12 feet in circumference. It covers an area of 2,700 sq. yards and the average yield of the tree is 450 mds (37,000 lb). The tree also lives long and the original tree of the variety Borsha at Kalamsar in East Khandesh is said to have been alive after 300 years. Of course, grafted trees do not live this long.

In many parts of India the mango is the mainstay of the people during the fruiting season. It is one fruit which almost everyone gets to enjoy. The juicy sucking varieties are consumed in large quantities. Nobody will think of eating a dozen apples in one sitting, but a mango-lover will gladly finish 5 lb. of sucking mangoes in one session and forego a meal. Mango is also made into pickles, preserves, mango-powder (*Amchur*) and chutneys of all sorts. Mango pickle is the most important pickle and along with mango chutney constitutes the most important item of export of preserved fruit products from India. The juice of the mango fruit is dried in the sun in the form of solid sheets called mango leather or *Ampapad* which is a sour-sweet pliable product. Small unripe fruits are used to make chutneys. Mature but unripe fruits are baked and the softened pulp is mixed with raw sugar. It is eaten with meals or diluted into a drink. Mango-fool, a refreshing drink, is made by mixing mango pulp with milk and sugar. Even the kernel inside the stone is not wasted. It is roasted and powdered and cooked into a gruel. It contains over 8 per cent protein. All mango kernels produced in India in a year are estimated to contain 70 million pounds of protein and 780 million pounds of starch. It is an outstanding source of vitamin A and a good source of vitamin C, apart from the usual content of minerals and other vitamins. Good mango varieties contain over 20 per cent of total soluble solids (sugars) in which the non-reducing sugars are more than the reducing sugars. The acid content of ripe dessert fruits varies from .2 to .5 per cent and the protein content is about one per cent. The mango is also considered to have some medicinal properties. The ripe fruit is fattening, diuretic and laxative. The smoke of the burning leaves is supposed to cure hiccups and some throat troubles and the kernel is effective against diarrhoea and asthma. Baked and sugared pulp is given to patients of cholera and the plague. The bark is a source of resins and gum. The gum and the resinous substance exuded by the stem-end of the harvested fruit are mixed with lime-juice and given in cases of scabies and cutaneous afflictions. The bark is used in the tanning of leather. The wood is used in many ways. It can be used as

timber for building houses, provided it does not come in contact with water which causes it to decay. It is also used in making packing cases and percussion drums. Its leaves can be used as fodder. Thus the mango tree is fully utilised in India.

Botanically the mango belongs to the family Anacardiaceae, to which also belong the cashewnut and the pistachio-nut. *Spondias pinnata*, the Indian hog plum or *Amra* found in Bengal, Assam and Bombay and *Buchanania latifolia* are wild fruits found in India belonging to the same family. The pepper tree (*Schinus molle*) found in Bangalore also belongs to this family. The cultivated mango belongs to the species *Mangifera indica*. Wild mango forests of this species and of *Mangifera sylvatica* are found in Assam. Another species *M. khasiana* is said to have existed in India, but has now become extinct. Other species of *Mangifera* such as *pentandria*, *odorata*, *foetida*, *longipetiolata*, *caesia*, *altissima*, *quadrifida* and *maingayi*, which are found in South-East Asia and the Philippines, are not found in India.

There is some doubt about the place of origin of the mango. The genus *Mangifera*, to which the mango belongs, has originated in one of the countries east of India, but not in India itself. However, the mango itself has probably originated in the region of India adjoining Burma. The names of this fruit in other languages, like the mango in English, the *manga* or *mangga* in Malaya and Java and *Mang-kwo* in Chinese seem to have been derived from the Tamil name *mankay* or *mangay*. Its English name seems to have been derived through the Portuguese.

The mango had become established in India at a very early stage. The invading armies of Alexander the Great found it established in the Indus Valley in 327 B.C. It is now a common fruit in all of the Malay Archipelago, Indonesia, the Philippines, the West Indies and Madagascar. It has also been introduced into many other lands like Brazil, the U.S.A. and Queensland in Australia. It had become established in Somaliland on the eastern coast of Africa before 1331. By the 16th century, it had reached the Persian Gulf. By 1690, it was growing under glass in England. It had also reached Yemen in the latter half of the 17th century.

It reached the Canary Islands in the 19th century, the Azores in 1865 and Italy in 1905. It is also common in Egypt. It was taken to Brazil in South America from India by the Portuguese early in the 18th century, thence to Barbados in 1742 and also to other places in the West Indies. In its eastward travel it reached the Philippines after 1600. From here it was taken to Mexico by the Spanish traders much before 1778. From Mexico it is reported to have reached Florida between 1833 and 1862. It is interesting that it reached Florida in the U.S.A. and the West Indies from two different directions. It reached Hawaii islands about 1865 and Queensland in Australia in about 1870.

The mango is grown in almost all States of India. The reports of the area under mango in India have shown a decline from 2.4 million acres to about 1.5 million acres during the past few years. This discrepancy is due to erroneous estimates and does not represent an actual decrease in area. A large number of mango trees are growing on road-sides or in isolation on boundaries of fields. The estimation of their numbers is extremely difficult. The fluctuation in the area under mango is primarily due to error in the estimation of these trees. The estimates of the percentage of the total area under mango in India found in U.P., undoubtedly the most important mango producing State, have varied from 70 per cent to 40 per cent. As will be seen from the figures given on the next page, the other important mango-producing States are Bihar, Andhra Pradesh, West Bengal, Madras and Orissa.

The estimated production of mango fruit from an area of 1.46 million acres @ 4 tons per acre comes to 5.84 million tons. The low production is due to the neglected condition of the mango groves, which often consist of densely-planted tall trees of the juicy sucking varieties. No manuring, irrigation or plant protection measure is adopted. However, the old orchards are being gradually felled for timber and new ones, more scientifically planted and looked after, are taking their place.

SOIL AND CLIMATE

Mango is not very exacting with regard to its soil requirements.

AREA UNDER MANGO IN INDIA

State	*1953-54* (acres)	*1956* (acres)
Uttar Pradesh	1,322,656	538,383
Bihar	217,517	217,517
Andhra Pradesh (including Hyderabad)		181,391
Hyderabad	31,215	
Madras (including Malabar & Andhra, except Hyderabad)	250,900	
Madras (including Malabar)		100,459
Travancore-Cochin	13,039	23,031
West Bengal	187,073	180,866
Orissa	48,000	78,000
Gujarat & Maharashtra except Vidarbha	27,701	31,889
Madhya Pradesh	31,526	54,693
Punjab & Haryana	30,130	22,103
Mysore	26,720	26,105
Assam	25,000	
Others	1,375	
Total	2,212,852	1,459,294

It grows successfully in almost all States. It is a large tree with a deep tap-root system. The nature of the sub-soil is, therefore, important. The water-table should be below 6 or 8 feet. Sand, clay, very heavy black soils and soils with hard substratum or marl have not been found very suitable. Deep alluvial soils of the Indo-Gangetic plain are ideally suited for mango cultivation. The well-drained laterite soils of Ratnagiri and Goa on the West

Coast, the red soils of Dharwar, the medium-black soils of Peninsular India, the soils of the delta regions and the deep red loams with a substratum of loose gravel found in Madras are almost equally suited. Even the rocky, light loamy soils at the foot of the Himalayas are satisfactory. A well-drained, deep loamy soil is generally conducive to successful mango culture. Even the Kankar soils (with lime nodules) found in Gwalior, if not alkaline, produce good mangoes. Alkaline soils are especially injurious to young plants, which are burnt up. The pH of the soil between 5.5 and 7.5 is desirable.

Mango is a tropical as well as semi-tropical plant, which grows almost all over India. It grows up to an altitude of 4,000 feet, but the fruiting is poor above 2,000 feet. In some places mango is seen growing side by side with tropical fruits like banana, pineapple and coconut, while in others it is found growing along with temperate fruits like strawberry and some varieties of peach and plum. The two important considerations for mango cultivation are a frost-free, dry period at the time of flowering and sufficient heat during the ripening of fruits. Mango is damaged by frost at temperatures below 34°F to 36°F. Grafted plants are more susceptible than seedlings, especially during the first three years. There are also varietal differences in frost-resistance. Mango can grow at temperatures between 40°F and 110°F. Ideal growth takes place at 75°F to 80°F. The bearing is not good if the humidity is high throughout the year. The time of flowering is affected by the climate. Flowering takes place at different times in the different regions. In North India it takes place in February, but in the south it may start in September, or be as late as November. Consequently, the ripening time in different regions also varies considerably. In Kerala the crop is ready in February. In Madras, Andhra Pradesh and Maharashtra, the main fruiting season is in May, in Bengal the month of June and in U.P. the month of July. Off-season fruits are also common.

Frost at the time of flowering is very injurious. Mango blossoms are easily damaged and the fruit-set is affected. Rainfall and cloudy weather at this time also damage the flowers, cause an attack of powdery mildew and interfere with the activity of flies and other insects responsible for pollination. The result is a poor fruit-set or none at all. Mango grows successfully in areas with an annual rainfall of 30 to 75 inches with little or no irrigation. With adequate irrigation, it grows even in drier areas. A heavier rainfall can be tolerated provided it does not occur at the time of flowering and fruit-ripening, especially the former. Such are the conditions found in the Konkan on the West Coast of India. However, the mature fruits are said to be damaged to some extent by heavy rains in this area. Wind storms at the time of fruit maturity are very injurious since they cause a heavy fruit-drop.

VARIETIES

The number of varieties of mango found in India is great. In fact, there are far too many varieties. The number of commercial varieties is estimated at over 1,000. In most other countries the commercial varieties are polyembryonic. For example, the famous varieties Cambodiana, Carabao, Piko and Victoria from South-East Asia and the Philippines are polyembryonic. In these varieties, several seedlings with independent root-systems arise from each seed. Only one of these is the result of sexual union between the male and the female parts of the flowers. This seedling gives plants different from the mother-tree. All other seedlings arise from the tissue of the mother-plant. The new plants arising from them give fruits exactly like those of the mother-tree. Under these conditions, plants are raised from seed and vegetative propagation is not required. Almost all Indian varieties are mono-embryonic giving only one sexual seedling from each seed. In order to raise true-to-type plants from a tree, vegetative propagation is necessary. In India only ten polyembryonic varieties are found on the West Coast. These are Olour, Goa, Salem, Chandar Karan, Bellary, Bappakai, Kurakkan, Mazagaon, Nileshwar Dwarf and Mylepalium. Climate seems to influence this character and the variety Mulgoba, which behaves as mono-embryonic in India, has been reported to be polyembryonic in Florida, in the U.S.A.

In the past mango was propagated generally from seed. On account of the formation of the seed as a result of cross-pollination, *i.e.*, the fusion of the female cell of the flowers with the male pollen from other trees, every tree raised from a seedling is potentially a new type. This has resulted in the accumulation of a large variety of types with rich and varied tastes, colour of fruit and other characters. Vegetative propagation during the past two hundred years has helped preserve these different types. Gardening during this period was the avocation of the aristocracy, who built up huge collections of varieties. The "Lakh Bag" near Darbhanga in Bihar, which was planted by the Moghul Emperor Akbar and had one lakh (100,000) varieties is a case in point. *Ain-e-Akbari*, the memoirs of this Emperor, published in 1590, provides the first record of the Indian varieties. Nurserymen have also tried to impress the customers with their large collections of varieties. They have ascribed all kinds of fanciful attributes to their varieties. This has led to great confusion and some varieties have acquired many synonyms. For example, the Alphonso of Bombay is also called Haafus, Aafus, and Badami in different places. Peter, Peter Pasand and Pairi are the same variety and so are Collector, Bangalora and Totapuri. Banganpalli, Benishan, Safeda (in Delhi) and Chapta are synonyms of the same variety. The same name is often used for different varieties. For example, the name Malda is used for Fazli in Calcutta and for Bombay Green in U.P. The Safeda of Lucknow and Malihabad in U.P. are different from the fruit of the Baneshan of Andhra Pradesh which sells in Delhi under the same name. Several workers have published descriptions of important mangoes of India and have tried to remove this confusion.

A large number of mangoes in India are of the juicy type used for sucking. Most of these are seed-propagated and thus do not belong to established varieties. Only a few sucking types belong to well-established varieties and are vegetatively propagated. These include Raspunia, Mithwa Sundershah, Mithwa Ghazipur, Hardil Aziz and Lucknow Safeda of U.P., Chinna Rasam, Cherukurasam and Pedda Rasam of Andhra Pradesh and Rajapuri of Gujarat. Most of the established varieties are, however, of the table type, which have firm fibreless pulp and which can be cut with a knife. These Indian mangoes are of excellent quality and there is hardly any fruit to compare with them. The only character requiring improvement in these varieties is the presence of a rather large single stone. However, in varieties like Langra and Dasheri the stone is quite small. The varieities are localised in their distribution. Some like the Langra, which grows not only all over North India, but also in Gujarat, are climatically more adaptable. Pairi, Totapuri, Mulgoba and its hybrids are also grown in Hawaii and Florida. Of the numerous varieties, the following are important.

Punjab and Uttar Pradesh

Dasheri: It is an outstanding mid-season variety of delicate taste. The flesh is fibreless. The fruit is elongated, dull yellow and medium-sized. The tree is rather small. It is an outstanding mid-season variety of moderate bearing and a somewhat regular bearing habit. It is good for canning and cold storage. It has also a good keeping quality.

Langra: It is a well-established mid-season variety of U.P., Bihar and the Punjab. It also grows on the banks of the river Narmada in Gujarat. The fruit is greenish, medium-sized, roundish-oval, the pulp very sweet and the stone very thin. The skin is thin and the keeping quality poor. It takes a longer time to come to full bearing, but eventually the trees are large, especially in the sub-montane tracts, and the yield is phenomenal after about thirty years. It is highly alternate-bearing. Benarsi Langra, Langra Hardoi and Langra Hajipur and some other strains have been mentioned, but all of them seem to be alike.

Bombay Green: It is also called Malda in U.P. and Sehroli in Delhi. Bombay Yellow is identical with this variety except that it develops a yellowish colour near the shoulders. It is an obliquely elongated fruit of green colour, very sweet taste and strong flavour. It is an early variety, which takes a little longer to come to full bearing and seems to be very susceptible to mango malfor-

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mation. The bearing is good and the keeping quality moderate.

Samarbehisht Chausa or *Khajri*: It is a moderately large fruit of extreme sweetness. It is a late variety of soft yellow colour. Its shape is characterised by the almost straight line formed by the beak and the apex. The bearing is moderate and alternate and the flesh is somewhat fibrous.

Other important varieties of this area are Gulab Khas, Fajri Zafrani, Khas-ul-Khas, and Krishan Bhog among the mid-season group, Taimuriya among the late group and Gopalbhog and Zardalu among the early group. Rataul is an early variety with small, but exceedingly sweet fruit. It has not spread due to its low yield.

Bihar

Bombai is an early variety which is called Malda in Bengal. The fruit is ovate, medium-sized and yellow. Its fruit quality and bearing are good, but it is highly alternate-bearing and the keeping quality is rather poor.

Gulab Khas is another early variety with elongated fruit, an attractive red blush and an excellent keeping quality. The fruit after storage for some days shrivels instead of rotting. The bearing is good and somewhat regular and the fruit quality good.

Himsagar has medium-sized ovate fruit of yellow colour and good fruit quality. The bearing is fairly heavy and the keeping quality good. It is a mid-season variety which is also important in Bengal.

Krishanbhog is a mid-season variety, which originated in Bengal. The fruit is medium-sized, roundish-oblique, yellowish and of a fair keeping quality. The fruit quality is good and the bearing heavy.

Fazli is also called Malda and is a late variety with large oblique, green fruit. The bearing is good and somewhat regular. The pulp is fibreless but of a mediocre quality and moderately good keeping quality.

Sukul is a late variety of Bihar. It bears heavily, has a good keeping quality, but the fruit quality is mediocre. The fruit is largish, oblong-oblique and yellow.

Other important varieties of Bihar are Langra and Bharatbhog (mid-season varieties), Sepia and Bathua (late varieties) and Mithua, Zardalu and Khas-ul-khas (choice varieties).

Bengal

Bombai Bhutto: It is a medium-sized ovate-oblique fruit of yellowish colour. The fruit quality is very good, but not the keeping quality. It is an important mid-season variety of Bengal.

Other important varieties of Bengal are Bombai (Malda), Langra, Fazli, Shadwala (Shadulla) and Himsagar.

Western India

Alphonso: It is also known as Hafus, Appus, Badami, Gundu, Khader and Patnam Jathi. It is one of the best varieties of India and thrives best in a humid coastal climate. It is believed to have originated in Goa. It has excellent fruit and keeping qualities. It is very suitable for canning and cold storage. The fruit is medium-sized, ovate-oblique and capucine yellow in colour. It is one of the few varieties exported from India. The bearing is medium. Recently, the fruits of this variety exported to Delhi have been found to suffer from an unknown disorder in which the flesh of the fruit develops spongy opaque yellow pockets. The cause of the malady has not been determined so far.

Pairi: It is also called Peter, Yerra Goa, Nadusalai, Grape, Peter Pasand, Gohabunder and Raspuri. It is an important commercial variety of Western India, though the fruit quality is much inferior to that of Alphonso. It has also been introduced into Hawaii. It is popular in South India and thrives better in humid areas. The medium-sized ovate fruit has a prominent red blush and is very attractive. It is an early variety with heavy but alternate bearing. The keeping quality is fair.

Fernandin: It is an important late variety of the West Coast of India. It is the oldest variety in the Konkan area and is believed to have originated in Goa. The medium to large-sized oval fruit with a yellow skin has a very good quality and bears heavily.

The other important varieties of this area are Cowasji Patel, a large-sized fruit used for making preserves, etc. Borsha of

Karamsad, which has spread from Gujarat to the interior areas up to Hyderabad, Jamadar an important variety of Gujarat which is believed to be a seedling of Alphonso and Kesar, and Salebhoy Amdi are the high-quality varieties of Gujarat.

Madras State

Bangalora: It is also called Totapuri, Collector, Sundersha, Gilli Mukku and Thevadiyamuthi. The extremely oblique, greenish fruit with a bright red blush is easy to recognise. The fruit is of poor quality, but is commercially very important due to heavy and regular bearing and an excellent keeping quality. For transport it is often loaded loose in railway wagons. The fruits are sometimes affected by the mango-stone weevil.

Neelum or Kaja Laddu is a late, high-yielding and regular bearing variety, which often gives two crops in a year. The small ovate-oblique, yellow fruit is of a fair quality and is a very good keeper.

Rumani: This variety is important due to its high yield and good keeping quality. The apple-shaped fruit is yellow coloured with a red blush on the shoulders. The fruit quality is moderately good, but if it is harvested even slightly early, the fruit remains sour. It sometimes bears a small second crop.

Raspuri or Pairi is also grown in this area.

Andhra Pradesh

Bangaupalli: It is also called Baneshan, Chapta, Chaptai and Safeda in North India, where it is sold regularly. The large-sized obliquely-oval fruit of yellow colour has a good fruit quality as well as keeping quality. The bearing is heavy and mid-season. It does well in dry areas.

Mulgoba: This late variety is popular in the interior dry areas of Peninsular India. The large, roundish-oblique, yellow fruit is of a good quality and is very suitable for making preserves and has a good keeping quality. Its yield is somewhat poor.

Suvarnarekha: It is also called Chinnasuvarnarekha and Sundari or Sandhuri in the Delhi market. It is a very early

variety of coastal Andhra Pradesh, which is spreading to other areas. It has a fairly good fruit quality and a good keeping quality and is exported to North Indian markets. The bearing is heavy. The medium-sized ovate-oblong fruit is green with a prominent red blush on the shoulders.

Other good varieties like Allumpur Baneshan, Jehangir and Himayudin are not important due to their poor yield, despite their excellent fruit quality.

Propagation

As indicated earlier, even though polyembryonic mango varieties, which give naturally occurring asexual seedlings and plants true to the mother-tree, are found in some other countries, almost all Indian varieties are mono-embryonic. Mango plants raised from seedlings, therefore, do not come true to the mother-tree. Artificial vegetative propagation is, therefore, necessary.

The mango has a deep tap-root, which gets cut off in transplanting the grafted plants. Consequently, the grafted trees are not as hardy, long-lived or large-sized as are the seedling trees. Seedlings raised from a mixed lot of seeds are generally used as root-stocks. It is believed that in mango the root-stocks do not influence the performance of the grafted tree. Stones from seedling trees are considered to give more vigorous plants and are preferred. However, root-stocks may be found to have a definite influence on the grafted mango plant. The slow growing variety Fazli has been found to delay the growth of the scion, when used as a root-stock, and the variety Kalapady has been found to be a dwarfing root-stock. Better frost-resistance can be had on root-stocks of wild seedlings.

Mango seeds lose their ability to germinate in about four weeks. The pulp should be washed from the stones at the time of extraction and they should be sown within a week. Some varieties like Bappakai germinate better and so do large seeds. Seeds floating in water should be discarded. A seed-nursery should be prepared under the shade of tall trees away from their trunk for protection from frost, hot winds and heavy rain. Seeds are sown

2½″ deep with the germinating end pointing up, along with the husk or without it. Medium clay soil or silt is the best sowing medium for easy lifting of seedlings with a ball of earth. Leaf mould or farmyard manure can be mixed in the soil with advantage. Three- to five-foot-wide seed-beds are prepared and the seeds are sown in rows one foot apart and seeds six inches apart. Addition of nitrogen in the form of 750 lbs. of ammonium sulphate per acre to the nursery soil is recommended. Sowing can also be done under three-foot high sheds, which are removed after the first flush of leaves has hardened. Germination takes place in about three weeks. Sometimes seedlings germinating in nature under the mango trees are also dug out and used as root-stocks. Only selected healthy seedlings are potted in earthen pots of various shapes, baskets of bamboo or knitted grass and bamboo pots about six to eight weeks after germination. The potting mixture should contain equal parts of soil, compost and sand or leaf mould. Humid weather at the time of transplanting is desirable. The seedlings can be transplanted with bare roots in cool humid weather, if most of their leaves have been removed ten days earlier. If the transplanting of seedlings is done when they are over eight months of age, many of them die in this process. Potted seedlings are kept in partial shade for about three weeks before grafting. The growth of potted seedlings can be hastened by applying liquid manure, which can be prepared by dissolving a handful of ammonium sulphate in a bucket of water or by mixing fresh cowdung with four to eight parts of water and stirring it daily for eight days. After this the clear liquid is decanted and applied to the pots two or three times at intervals of about two weeks.

Polythene film is being used increasingly in horticulture. One of its uses is wrapping seedling root-stocks in it, instead of putting them in pots. According to one nursery in Saharanpur, the seedling is dug out with a ball of earth in the usual manner. After one day most of the soil is removed and the roots are covered with moss grass or hay, the roots are dipped in water and the plants stacked upright in shade for eight days and watered regularly. The roots and moss are then wrapped tightly in polythene film and used for grafting and hung directly from the scion branch. Thus no watering or support for the seedling is required during the period the seedling remains attached to the scion.

The only commercial method of grafting mango followed so far in India is inarching or enarching, which is a type of approach-grafting. It is a laborious process, but the other methods give poor results. It has been suggested that inarching was started by the Portuguese Jesuits in Goa about 300 years ago. It has also been claimed that it was started by the Moghuls in Pinjore near Chandigarh. However, it has been mentioned in old Sanskrit literature and has been prevalent in India since ancient times. Seedlings can be inarched when they are three months old, as is done in the Philippines. The Indian nurserymen usually inarch one-year-old seedlings. Grafts using older seedlings give a poor root-system. In the Ratnagiri area on the West Coast nurserymen often inarch a thick scion on two rootstock seedlings grown together, in order to get larger plants. Such plants perform poorly afterwards.

At the time of inarching, the seedling stock has the thickness of a lead pencil. The potted root-stock is placed on a suitable platform near a one-season-old scion shoot of equal thickness, on the mother-tree, from which a new plant is to be raised. Nine inches above ground level, a two- to three-inch-long slice of bark and wood is removed from the root-stock. This cut removes about a third of the thickness of the stem and tapers gently towards the top and bottom. A corresponding cut is made in the scion shoot, so that the two cuts fit in perfectly without leaving a chink. There seems to be no advantage in modifying this simple cut into the form of a tongue by an additional cut in the stock and the scion. The two cuts are placed face to face and tied firmly with banana fibre, and then with twine over it. The union is then covered with a mixture of cowdung and mud in equal parts. Tying can also be done with a cloth tape dipped in a mixture of bees wax and tallow or with polythene tape. Monsoon and February-March are good seasons for inarching in North India, and January-February in Peninsular

India. At the time of the operation, there should be no rain. Otherwise, water gets inside the union and causes rotting of tissues. The root-stocks in pots are regularly watered as required. The stock and the scion unite in about six weeks. The scion shoot is given a knife-cut through half its thickness below the union. After 10 days if the scion shows no wilting, the cut is completed. After another two weeks, the top of the root-stock above the union is cut off. The grafted plant now has the roots of the seedling stock and the top of the mother-tree to be propagated. About 90 per cent success is obtained in this method. The grafts are hardened in partial shade for another two months before planting. From the time of sowing of seeds, the grafts take one and a half to two years to be ready for planting in the field.

Instead of supporting the potted root-stocks on wooden platforms for inarching, in some places they are hung by ropes from higher branches of the mother-tree or the scion shoots are pegged down with ropes, so that the pots with root-stocks may be placed directly on the ground. A nursery in Saharanpur in U.P. has perfected a method of closely planting the mother-trees and then topping them to encourage the growth of scion shoots close to the ground, so that pots containing the root-stocks can be placed on the ground.

Recently propagation by veneer grafting has been perfected. This method differs from inarching in that the scion is completely detached from the mother-tree at the time of grafting. The scion shoot consists of a healthy 9″-long terminal shoot of the previous season's growth. Its leaf-blades are cut off above the petioles about 10 days earlier. At the time of grafting, the buds on the scion should be ready to sprout. This is the most important factor for the success of this method. It can be done any time from spring to early monsoon. Success up to 80 per cent can be easily obtained. The grafts make rapid growth and are cheaper to produce. The grafting can be done on root-stocks raised in pots or in the field (*in situ*). This method is particularly useful for making a collection of mango varieties, since the scions can be removed from the mother-tree and easily brought for propagation from distant places. Inarching *in situ* is also practised in places like Gujarat, but it is tedious. In this case an inarched plant in a pot is brought to a seedling stock planted in the field. The scion above the graft union is united with a two-year-old root-stock in the field in the usual way. After the new union has taken place, the root-stock in the pot is cut away below the new union. Plants raised thus have an undisturbed tap-root, but the method is cumbersome and the raising of seedlings in the field for two years is laborious.

Some other methods of grafting are also practised but these are not important. In Salem and Chitoor districts of Madras State, saddle-grafting is sometimes done. In this method, the root-stock is headed back and shaped into a wedge, which is inserted into a V-shaped cut in the scion, which is still attached to the mother-tree. Side-grafting, whip- or splice-grafting and root-grafting are also successful in mango.

For top-working of old mango trees of inferior varieties with better varieties, several grafting methods have proved successful. The top of the tree is cut off and new branches are allowed to grow. One or two of the old branches called sap-drawers are retained on the tree till the new grafts have made some growth. After heading back the tree, the trunk is covered with gunny bags, newspapers or is whitewashed to save the bark from cracking due to a strong sun. The whitewash for this purpose may be made of 5 lb. of lime and half a pound of zinc sulphate dissolved in two gallons of water. The new shoots arising can be grafted when two months old by veneer-grafting or side-grafting (in coastal areas), a modified form of which is practised in South India. In humid conditions, grafting of small branches which have been headed back can be done by cleft-grafting or crown (bark) grafting. The scions in this case are prepared as in the case of veneer-grafting. In crown-grafting it is desirable to enclose the scions in a circular cardboard enclosure covered on the top with a glass plate. Moist sawdust is packed around the scion inside the cardboard, leaving only the top bud exposed.

Budding of mango was tried in Madhya Pradesh and at Saharanpur in U.P. as early as 1899, but these early attempts were unsuccessful. However, with proper preparation of the bud-wood, budding can give success up to 75 to 85 per cent, especially under humid but rain-free conditions. Budding *in situ* is particularly useful. The bark of the young mango seedlings does not separate easily in young age. So the root-stock should be at least two or three years old. The buds are taken from one-season-old mature shoots, from which the top immature part has been cut off and the leaf-blades subtending the lower six or seven buds have been cut off above their petioles. After 10 to 15 days, when these petioles have fallen off, the buds are ready for use. The best season for budding has been found to be August and September in Poona, June and July in Sabour, and April or September (followed by June) in the Punjab. In September-budding, the budlings make little growth till next spring. The budding operation should be performed quickly so that the resinous sap exuding from under the bark does not get time to solidify. Several methods of budding have been tried. These include shield-budding, Forkert-budding, chip-budding, patch-budding, window-budding, flap-budding and 'H'-budding. In Forkert-budding, a bud along with a square patch of bark is inserted on a corresponding portion of the stem on the root-stock from which a piece of bark has been pulled down. The bark is then pulled up over the bud and the whole thing is tied with polythene tape or raffia, etc. The bud is thus loosely covered with a patch of bark. After a fortnight, the root-stock should be ringed four inches above the bud. Three weeks after budding, the tape is removed and the flap of the bark is cut off. In another three weeks, growth starts. The bud-wood, with its cut ends dipped in grafting wax, can be stored in a cooled thermos containing one-fourth-inch deep cold water at the bottom. This water should be replaced daily.

The mango grafts should not be left in the pots too long, otherwise their roots become crooked, entangled and pot-bound. After trimming off roots, they can be temporarily planted in the ground. The grafts are generally transported by rail along with the pots or their earth-balls tied in straw *jutties* or in polythene film. Six to ten plants are packed in mulberry baskets for despatch. In view of the rough handling in rail transport, it is preferable to pack them in wooden crates in two parallel rows, with a long wooden handle

in the middle. Very large grafts often die in transit or after planting. Therefore, the grafts should not be taller than two feet.

A method of sending grafts quickly by parcel post with bare roots has been suggested. The plants are kept in the sun for two weeks and watered sparingly to harden them. After this their leaf-blades are clipped off, leaving the leaf stalks. They are removed from the pots and the roots are washed free of soil. About a dozen such plants can be wrapped together in moist sphagnum moss or straw and then covered with wet blotting-paper, gunny bag and polythene film, tied with a rope and placed inside a light wooden box. On reaching the destination, the roots of the plants are submerged in water for an hour, they are potted and kept in shade for a few weeks before planting.

Planting and Care of Plants

Planting of evergreen plants is generally done with a ball of earth in the beginning of the rainy season on a rain-free day. In areas of heavy rainfall, the planting is delayed till the end of the monsoon season. In North India, planting can also be done in February-March, if assured irrigation is available. The plants inarched during the previous season are generally ready for planting at this time, and make quicker growth if planted in the field at this time. The planting is done in previously-dug, exposed and filled pits of the size of 3′×3′×3′. Sometimes brushwood is burnt in pits before filling them. This improves the structure of the surrounding soil and adds potassium in the form of ashes. The field is levelled, ploughed and cleaned of weeds before the digging of pits.

The application of nitrogen to young plants hastens growth. Before filling the pits, 25 to 50 lb. of well-decomposed farmyard manure should be added to them along with 1½ lb. of bonemeal and 2½ lb. of wood ashes. A heavier dose consisting of 100 lb. farmyard manure, 5 lb. bonemeal and 100 lb. ashes has also been recommended. Fresh cowdung produces too much heat and attracts white ants. Where white ants are a serious problem, the manure is applied two months before planting or six months afterwards. Planting is done on a cool day or in the evening and the plants are watered immediately. The wrapping from the union of the graft is removed, if not already done.

The planting distance varies greatly. The old orchards are often too densely planted and the trees grow very tall and upright. Cultivation in such groves is difficult, diseases and pests are very common and yields are poor. Generally, a planting distance of 40′ is satisfactory. In Gujarat and the coastal areas, where the trees grow very large the distance is increased to 50 or 60 feet. Seedling trees also grow very large and require to be planted up to 60 feet apart. In heavier soils of the Deccan and the Karnatak, growth of the trees is less and they are planted 30′ apart. The planting distance also varies according to the variety. A variety like Langra needs to be planted 50 feet apart, whereas a distance of 30′ to 35′ is adequate for Dasheri under the same conditions.

Since mango trees take several years to grow to their full size, inter-cropping and planting of filler trees, in order to utilise the inter-spaces, is very important. Papaya, phalsa (*Grewia subinaequalis*), guava, plum and peach can be planted as fillers, depending upon the climate. Fillers are generally planted between the rows of mango trees, but additional rows of fillers can also be planted. In interior parts of Maharashtra, dwarf bananas are planted as an inter-crop for the first two years. It saves the young mango trees from heat and seems to have no ill effect on the mango plants. Pineapple, lady's finger, cape gooseberry, cowpeas (*Vigna sinensis*), potatoes, cucurbits, groundnut, *guar* (*Cyampsis psoralioides*), beans (*Dolichos lablab*) and other vegetables can be used as inter-crops. Cover-cropping during the rains is important. It prevents erosion of soil and leaching of fertility. *Sesbania aegyptiaca* and *Crotalaria juncea* can be used for this purpose and buried in the soil for green-manuring.

In areas where frost is a hazard, the young plants are covered with thatch on three sides and the top during very cold periods. The thatch cover is kept open on the eastern side. Sometimes the young plants need protection from hot winds in North India in summer. Temporary live hedges can provide this protection.

Often the young plants produce some flowers. These are pinched off during the first five years. No pruning is done during the non-bearing stage except for removal of bunchy tops, if this disease appears. Cultivation of the orchard is required twice a year. Weeding is important in the rainy season. Clean cultivation during the dry season combined with cover-cropping during the monsoon is recommended. Some varieties like Bombai are said to do poorly if cultivation is neglected. The old neglected mango groves improve considerably if they are cultivated. Mango requires no pruning in the later years also, except removal of dead, dry and diseased wood and removal of branchlets on which the plant parasite loranthus is growing.

Mango needs 50″ to 70″ of precipitation annually, but on account of its deep tap-root system, it requires little irrigation after the first few years. No irrigation is practised in Bengal, Bihar and on the West Coast of India, and very little in Peninsular India. When the planting is done in spring, the young plants require irrigation every fourth or fifth day during the first summer till the rains break. During the rains irrigation should be given only if the soil dries up. In winter irrigation every two or three weeks is sufficient. During the second summer, the young plants should be irrigated every week or ten days. The bearing plants are often given no irrigation but irrigation from flowering to harvest-time reduces fruit-drop and gives larger fruits. It does not improve fruit-set, which is adversely affected by high temperature. This is the most important period for irrigation, the frequency of which is influenced by the type of soil. In black cotton soils which are moisture-retentive, no irrigation of bearing trees is practised, but these soils are not otherwise good for mango cultivation. Irrigation during the monsoon is hardly ever required. Alluvial soils of the Indo-Gangetic plain, red soils of Dharwar and red laterite soils of the Konkan Coast are moisture-retentive and require no irrigation even if the rains fail for several weeks. Irrigation from then on to the time of flowering should be withheld. This increases flowering. However, irrigation should be given during December in the off year. Irrigation of young trees should be done by the modified ring method and of the bearing trees by flooding or the furrow method. On the Ratnagiri Coast in Maharashtra, a 10-foot round mound is made around the trunk of each tree. Watering is done by hand on top of this mound, which retains moisture for a long time.

There are few mango orchards which have received any fertilisation, but they would greatly benefit from this practice. Fertilisation of mango has been recommended only during the last 50 years. Nitrogen is the most important nutrient required. It greatly improves growth especially if potash and phosphorus are present in sufficient quantities. Flowering and fruiting are proportional to the vegetative growth. Optimum nitrogen also improves the uptake of potassium, but its excess depresses it. Mango can withstand deficiency of phosphorus, but not of potassium. The yearly requirements of mango are estimated at 1.6 lb. nitrogen, .4 lb. phosphorus and 1.5 lb. potassium per tree of full bearing age. This can be supplied in the form of 200 lb. farmyard manure, 4 lb. of castor cake, 10 lb. bonemeal, 2 lb. ammonium sulphate and 30 lb. wood ash. In a year of heavy bearing, the ammonium sulphate should be increased to double this quantity, which should be applied in June along with half of potash. The other ingredients are applied in October. In Maharashtra an old recommendation suggests a graduated dose according to the age of the tree. It consists of 25 lb. farmyard manure, 5 lb. bonemeal and 10 lb. wood ash during the first year of the tree. These quantities are annually increased by 10 lb., 1 lb. and 2 lb., respectively, with a maximum dose of 100 lb., 15 lb. and 30 lb. respectively. Another manurial recommendation suggests a mixture of one part blood meal, one part superphosphate, a half part bonemeal and one part sulphate of potash. Six ounces of this mixture are required for a one-year-old tree, 12 oz. for a two-year-old tree and 4 lb. for a bearing tree. A more liberal dosage has also been recommended. It consists of 10 lb. farmyard manure, 3 lb. neem cake, 3 lb. bonemeal or superphosphate and 1 lb. potassium sulphate for one-year-old trees. The dosage is increased by 5 lb., 4.5 oz., 11.5 oz. and 11.5 oz., respectively, for every year of age of the tree.

The manures and fertilizers should be thoroughly mixed in the soil under the crown of the tree before irrigation. In areas of heavy rainfall they should be applied before the commencement of the rains or after their cessation. In Coastal Maharashtra, some growers apply 10 lb. common salt per tree in September. It has no nutritive value and should not be applied. Its usefulness in causing cessation of vegetative growth and promoting flowering has also been questioned.

Mango requires little pruning except removal of diseased and over-crowded branches and those arising within about two feet above ground-level. This helps keep the soil free of weeds by digging and thus eradicates pests like the mango mealy bug. The best time for pruning is after the monsoon.

Mango continues to bear fruit for many years. Grafted trees bear good crops for 50 or more years. However, there are many orchards of seedling trees of over 150 years of age. Even 300-year-old trees are found. Many of them are over-crowded and in poor condition. These can be renovated by uprooting some of the over-crowding trees and severely pruning the others. The pruning wounds should be covered with Bordeaux paste containing copper sulphate and lime. Use of hot coaltar to cover the pruning wounds is not desirable though often practised. If the trees are of inferior quality, they should be top-worked with superior varieties. This can be done by veneer-grafting, crown-grafting or side-grafting, etc. The exposed trunks of the beheaded trees should be covered, as discussed before. The orchard should be thoroughly ploughed, manured, irrigated and sprayed against insect pests and diseases. This can change the trees unbelievably.

Grafted mango trees start bearing from the age of five years and commercial crops can be obtained in about seven years. Seedlings take about 10 years. Most varieties give a high yield, but fail to bear regularly every year after the age of about 10 years (in grafted varieties). A year of good crop may follow one or more years of a poor or no crop. It has been reported that in Maharashtra there is one good crop in three years and in Bihar one in six years. However, there is no hard-and-fast rule. However, every area develops an "on year" with consequent glut and low prices and an "off year" with practically no crop.

In the past the problem was considered to be purely physiological and capable of solution by proper irrigation, manuring and ringing of shoots in the on year. In the Philippines smudging of the orchard is done to induce flowering. However, the heat and the ethylene gas created by smudging only hasten flowering and cannot produce flowers if the shoot has not already differentiated the flower-buds or does not have the potential to flower. Root-pruning is also ineffective.

Some varieties like Langra and Bombai have a stronger tendency to irregular or alternate bearing which cannot be controlled by any means. Others like Dasheri, Bangalora, Neelum and Baramasi are much less alternate-bearing. In mango the vegetative growth takes place in three to five flushes in different parts of India. Shoots arising after September do not mature in time to give flowers in the following year, except in varieties like Neelum, Suvarnarekha and Baramasi. So the object of all cultural practices should be to secure an early vegetative growth in the "on year". This cannot solve the problem completely, because any branch on which fruits of the size of a marble have appeared seems to produce some chemical substance, which prevents flowering the following year. Many of the regular bearing varieties have a poor yield. Attempts are, therefore, being made to evolve a regular-bearing variety of good yield by breeding.

Another problem in the bearing of mango is that in many varieties of high-fruit quality like Rataul, Allumpur Baneshan, Himayuddin and Jehangir, the yield is very low. The flowering panicle of mango is very large containing 800 to 9000 flowers in different varieties. Yet at harvest-time, a panicle may carry one fruit or none or rarely two fruits. This means that often less than 0.1 per cent of the flowers mature a fruit. This is due to the presence of a large number of flowers in the panicle with male functional parts (anther) only. The percentage of perfect flowers varies from 1.25 in Jehangir, 6 to 11 in Alphonso, about 30 in Dasheri to 70 in Langra. About 99 per cent of these flowers fail to set fruit for various reasons, including lack of cross pollination, which is done mostly by flies of various species. The weather conditions affect the activity of these insects. Low fruit-set is also a problem in regular-bearing varieties with mixed panicles and bearing more than one crop in a year. The situation is further aggravated by a heavy fruit-drop in mango. It can be solved by breeding a superior variety.

The mango fruit ripens in about 90 days after flowering. It can be successfully ripened artificially after harvesting, is perishable in the fully-ripe condition and should be handled like eggs, as has been indicated in the case of apples. Harvesting at maturity followed by artificial ripening at the consuming centre protects the fruit from rough handling in transit and damage from birds on the tree. All fruit on a tree is generally harvested when a few fruits ripen naturally and fall from the tree. The specific gravity of the fruit at this stage is generally between 1.01 and 1.02. Another criterion for harvesting is a slight change of colour in coloured varieties like Alphonso and Dasheri or appearance of blush in others. In green varieties the colour changes to oil green and in Pairi and Cowasji Patel the surface of the fruit becomes somewhat uneven. The fruit is harvested with a harvesting pole. At the end of the pole two iron strips are tied together to form a 'V' crotch between which the fruit is caught and pulled. Below this notch a small net basket with a ring around the neck is attached to receive the fruit in it.

The harvested fruits are kept in the open for a day, then ripened between layers of straw, grass or other soft dry matter. Ripening should be slow and should take about a week. The temperature of the stacked fruit rises 8°-10°C above room temperature. Above 36°C (97°F), the fruits begin to spoil. When the temperature of the fruit goes above 33°C (91.5°F) after about four days, the fruit is taken out and spread on top of straw in a single layer to complete the ripening slowly. However, it has been shown that fruit ripened slowly at a temperture as low as 67°F develops a better quality and colour. The fruit can also be ripened by wrapping it individually in paper. Fruit ripened artificially is said to develop a better flavour and taste than tree-ripened fruit. The fruit can be ripened quickly in about two days if a small piece of calcium carbide is placed in a covered heap of mangoes. The acetylene gas emitted by the calcium carbide gives the fruit good colour but the eating quality remains poor. Late varieties are often harvested early to save cost and are ripened by this method.

The yield of mango varies greatly. Varieties like Langra take about 20 years or more to come to full bearing. At this stage they bear tremendous crops. The overall yield for the country is about three to four tons per acre. In the "on year", a good crop consists of about 14 tons per acre. The number of fruits per tree generally varies from about 20 fruits in the fifth year to 1000-2000 fruits at 20 years. In areas like Ratnagiri on the West Coast and at the foot of the Himalayas, heavy-bearing varieties give up to 4,000 fruits in the "on year".

Mango fruits perish very soon. Varieties like Alphonso and Dasheri can be kept successfully in cold storage for 40 to 60 days at a temperature of 48°F. Mature fruits can be stored at 42° to 45°F and then ripened at 67° to 70°F.

DISEASES AND PESTS

Mango Malformation: It is the most serious malady of mango, which is becoming a menace in North India. It is not common in South India. Some varieties like Bombay Green and Fajri Zafrani are more susceptible than others. The Bhadran variety of U.P. is reported to be free from it. The diseased inflorescence becomes clustered and rounded, most of the flowers lack essential organs and do not set fruit and the inflorescence continues to hang on the tree for months. The malady also affects the vegetative shoots and is called bunchy top in this form. The apical end of the shoot forms a crown of small leaves with greatly reduced internodes between the leaves. No definite remedy against it is known, though cutting and burning of the affected branches is suggested. First the cause was considered to be small insects called mites and then a virus was suspected, but recently there is evidence that it is caused by a fungus, *Fusarium moniliforme*, which can be controlled by spraying .1% captan.

Anthracnose: This has been reported from the Punjab and U.P. The disease causes black spots on shoots, which dry up. Dry burnt spots appear on leaves, the fruits fall, remain stunted or the mature fruits develop cracked black spots, especially towards the stem-end. The blossoms also become blighted. It develops in very humid weather and is caused by the fungus *Colletotrichum gloeosporioides*. Two other species of fungi have also been reported, *C. mangiferae* in U.P. and *Gloeosporium mangiferae* in the Bombay area. They all seem to be identical and can be controlled by spraying 3-3-50 Bordeaux mixture in February, April and September.

Black tip: It seems to be caused by the gases in the smoke of the brick kilns. It is found on mangoes grown up to a distance of 700 yards to one mile from the kilns. It is not found in South India, where kilns of the type used in the North are not found. The distal end of the fruit develops black, hardened spots and the fruit may drop prematurely. The remedy lies in planting orchards away from the windward side of the kilns, or keeping the height of their chimneys at least 50 feet. A few sprays of borax 6 lb. in 100 gallons of water) at blossoming and afterwards are also beneficial.

Powdery mildew: It is found at the foot of the hills. In the Bombay area a 20 per cent loss from it has been reported. The fungi *Erysphae cichoracearum* and *Oidium mangiferae* cause powdery growth on flowering stalks and leaves, which fall off. Dusting with 250-300 mesh sulphur or three sprays at fortnightly intervals of wettable sulphur in spring can control it. Sprays of a mixture of 50% sulphur and 5% DDT or Guesarol are more effective.

Other diseases of mango found in India include the sooty mould, black spot, soft rot of fruit and bacterial rot of fruits. The stem end rot caused by *Diplodia natalensis* can be prevented by dipping the fruit in Auriofungin (500 to 1000 ppm). Recently, the Alphonso fruit has been showing the presence of a spongy opaque tissue, which ruins the inside of the fruit. Externally the appearance of the fruit is not affected. The cause of the disorder is not yet known.

Mango-hoppers: They are the most important pests of mango found all over India. There are three species of these tiny insects sucking the sap of the tree—*Idiocerus atkinsoni*, found mostly on the trunks and branches in North India, *I. niveosparsus*, and *I. clypealis*. Their population is enormous in spring and summer. The adults spend the winter in cracks in the bark and lay eggs on young flowering and vegetative shoots in spring. The nymphs and adults suck the sap and flowers and tiny fruits fall. Damage may go up to 60 per cent of the crop or even 100 per cent. The thick sticky excretion of the insects falling on the leaves encourages the growth of sooty mould, caused by *Capnodium mangiferum*, which causes difficulty in the respiration of the plant. DDT (W.P; 0.25% spray) or 0.2% endrin spray are most effective in controlling the pest. One spray in winter and another in spring before the opening of flowers are recommended. However, DDT also kills useful insects acting as predators of mites and scales, which become a problem after spraying. An equal or double amount of wettable sulphur should, therefore, be mixed with DDT to keep the mites and scales under control. Sulphur also controls the sooty mould.

Mango mealy bug (*Drosicha mangiferae*): It causes damage to mango in North India. It also attacks many other plants including guava, citrus fruits and jujube or ber. The male adult is winged and does not do any damage. The female crawls down from the tree and lays her eggs in the soil under the trees. The eggs remain in the ground during winter. In February the young ones crawl up along the trunk and suck the sap of the young shoots. They also cause an attack of sooty mould. The soft, white waxy insects cause damage from February to June and are seen clustered on the young shoots. To control it, the soil under the trees should be dug up after the monsoons and treated with BHC 10% early in January and adhesive bands placed around the trunks of the trees in December. These are effective for six to eight weeks. Renew the bands in mid-January. The material for the bands can be prepared by boiling together rosin (6 lb.) and castor oil (5 lb.) for 10 minutes. The castor oil can be replaced by rape seed oil (2 lb). Other materials including some proprietary products can also be used for banding. The insects on the branches can be killed with a spray of .1 per cent Parathion.

Mango-stone weevil: The weevil lays eggs on the surface of the fruit. The young insects bore through the pulp and eat into the seed. Later the adults eat their way out of the fruit. From the fruits of the variety Totapuri or Bangalora when the pulp is removed, the insect flies out of the seed. Probably the pulp of this variety contains something which discourages the insect from eating its way out. The species of the insect found in South India is *Cryptorhynchus mangiferae* and in Eastern India *C. gravis*.

Leaf galls: A number of insects cause formation of raised warts like galls on leaves and sometimes on shoots. The commonest insect is the Cecid fly (*Procontarinia matterana*). Tar oil wash in September or February reduces the damage.

Mango fruit flies (*Dacus dorsalis* and *D. zonatus*) are important in some areas. The affected fruits are given hot water treatment to kill the maggots inside them.

Other insect pests of mango include the red ants, which make nests by weaving together a cluster of leaves. They are a nuisance to persons working on the mango trees, and can be controlled by piercing the nests and dusting BHC or DDT mixed with sulphur. Other pests found in India are fruit flies, scale insects, caterpillars, shiny blue flea-beetle and other weevils. These are not important.

Mango fruits are generally transported before they are artificially ripened. Their packing and handling is therefore rough. Most of the fruit is packed in shallow and wide mulberry baskets covered with gunny cloth and lined with straw in North India. These baskets contain about 40 lb. of fruit. In Western India and the South bamboo baskets in which up to 100 fruits are packed in layers between straw or grass are used. Fruits of varieties like Bangalora are often loaded loose in railway wagons. The poor packing results in 16 to 20 per cent loss of fruit. The use of wooden boxes made of mango or silk cotton trees, etc., is gaining in popularity due to reduced loss of fruit. Usually the fruit is not graded except that the larger fruits are placed on the top of the container. However, in Bihar and Bombay, grading of fruits has been attempted. In Bombay grade I the fruit weighs over 320 gm. grade II 270 to 320 gm. and grade III under 270 gm. The Indian Standards

Institute is currently fixing all-India standards for the grading of mango.

The mango-grower gets a poor price for his produce. Fruit-growers' associations are coming up in Bombay, U.P., Madras and the Punjab to combat this. Mango sale societies in Ratnagiri and Dharwar are working on co-operative lines.

Mango was first exported to the U.K. from Bombay in 1896. Vigorous efforts are now being made to export mangoes to several other countries. This requires better grading and packing of fruit. The fruit of the consignment of Alphonso variety from Bombay to the U.K. in 1932-33 was individually wrapped in tissue paper and packed in single layers of 12 fruits in wooden trays lined with wood wool. Five such trays were tied together. In 1950-51 fruits of Dasheri variety were sent to London by air. These were individually wrapped in paper and placed in bamboo baskets containing 60 fruits in three layers. They reached the destination in a good condition.

It is apparent that the marketing of the most important fruit of India is still unorganised and primitive. With the development of the export trade and improving agricultural prices in the country, the marketing of this wonderful fruit will undoubtedly develop rapidly on modern lines.

CHAPTER III

BANANA

BANANA is one of the oldest fruits of the world. Its names "Adam's fig", "Apple of Paradise" and the botanical name *M. paradisiaca* are suggestive of its antiquity. The edible banana is indigenous to the warm moist parts of Asia and probably originated somewhere in the mountainous regions of Assam, Burma, Thailand or Indo-China. From here it has spread to tropical parts of America, Africa, Australia, the Philippines and Hawaii. When Alexander invaded India in 327 B.C., the Greek was greatly impressed by the bananas growing in the Indus valley. The banana appears to have been taken to Palestine and Egypt from India in the 7th century A.D. by the Arabs. It is not only the staple food of millions of people, but is also the most important commercial fruit of the tropical areas of the world now. Its cultivation has developed most in tropical America and has become highly industrialised. Honduras, Jamaica and also Brazil and Mexico are the biggest exporters of banana. The United Fruit Company which grows, buys and exports banana in this area is an empire in itself and operates in several countries. It is the biggest farming organisation in the world and owns several refrigerated ships to take bananas to North America and Europe.

Unlike most other fruits, banana is a herbaceous plant. The fruit is delicious and seedless. Disraeli called it the most delicious thing in the world. In many places soft ripe banana is the first solid food given to babies. Unripe banana fruit as well as the inner core of the pseudostem is regularly cooked as a curry in the banana-growing areas. The end of the inflorescence is cooked as a vegetable in Bengal. Chopped banana stems are used as cattle feed. It is a rich source of energy in the form of sugars and starch and is the cheapest fruit in India. It can give up to 50 tons of fruit per acre within a year or 15 months, and its cultivation can be the most efficient means of meeting the present grave food shortage in India. Unlike other fruits, it contains very little water. About two-thirds of the gross weight of the bunch constitutes the edible portion. Like potato, it yields highest amounts of energy-giving food per acre. The ripe fruit is a good source of vitamin A and a fair source of vitamins C, B_1 and B_2. The unripe fruit is even richer in vitamins, which are retained well even after cooking at a temperature up to 60°C. It is also rich in minerals like magnesium, sodium, potassium and phosphorus and is a fair source of calcium and iron. The ripe fruit contains up to 27 per cent sugars, which consist of both the reducing and the non-reducing types. In the cooking variety Monthan, glucose is the only sugar found. The sugar content varies according to the variety. The Nendran variety contains over 26 per cent sugars, Ney Poovan or Safed Velchi over 27, but Basrai only 15 per cent. The acid content varies from .4 per cent in Nendran to over 1.2 per cent in some others. Ripe bananas are dried into banana figs. Nendran or Rajeli and Rajapuri varieties are very suitable for this purpose. Nendran is also made into salted banana chips all over the Malabar coast. Banana pulp is also dried into flour. Apart from being a delicious nutritious and high-yielding fruit, which is the mainstay of the people in some parts of India, the banana has another equally important use. Its leaf is universally used as a plate for serving meals in various parts of India, especially in the South. The use of metal plates for this purpose is a practice which started in modern times and is found in very few homes. In Tanjore district in Madras State alone, 2000 acres of banana are reported to be cultivated exclusively for leaves. Plants of the species *M. balbisiana* and Monthan variety are especially grown for this purpose. Some species of banana also yield fibre. *Musa textilis* forms the basis of a regular industry for making Manila hemp in the Philippines and *M.basjoo* is used for making coarse fabrics in Japan.

Banana belongs to the genus *Musa* of the family Musaceae, which is closely related to the families of the ginger and the ornamental plant canna. Two wild species of *Musa* are found in India, *M. balbisiana* in Assam and *M. acuminata* in South India as well as in Assam. Almost all edible bananas have originated from the species *M. acuminata* and are designated as *M. paradisiaca*. This species also includes some cooking types. Other cooking types have originated as hybrids between the two wild species and have been designated as *M. sapientum*. The common English term plantain should be used for a cooking banana, but there is some confusion about its use in South India.

Banana bears enormous leaves on a pseudostem consisting of clasping leaf-stalks. The flowering stalk pushes out of the pseudostem and produces a large hanging bunch of flowers. The flowers are borne in the axils of brightly-coloured bracts. The basal flowers are female flowers, then appear the male flowers, followed by neuter flowers towards the tip. Pollination is not required for fruit-set. The pseudostem produces flowers only once and is cut off after fruiting. The fruits are called fingers, which are borne in hands of about 12 fingers each on the bunch. The bunch contains up to 150 fingers. The real stem is a greatly reduced underground corm, from which the pseudostems arise. It produces two sets of roots, one going down up to a depth of about six feet and the other spreading horizontally.

There are three important banana-producing areas in India—South India, Western India and Eastern India from Bihar to Assam. Most of the area in Assam and Bengal consists of small backyard plantations. The limiting factor in banana-growing is the frost hazard, which limits banana cultivation in the North-Western parts and on the hills. The total area under banana in India is 464,000 acres. It comprises 15 per cent of the area under fruits and is the second most important fruit crop. In many States like Madras, Assam and Kerala, it is more important than mango. Since it is not a perennial crop, the area under it fluctuates. For example, the area under banana in Orissa was 8,000 acres in 1961-62 and 28,000 acres the next year. Similarly, in Maharashtra, the area decreased from 65,000 acres in 1961-62 to 57,000 acres the following year. The leading centres of banana production are Tiruchirapalli, Malabar, the delta of the Kaveri river, Tanjore, Salem, and Palni Hills in South India, East Khandesh and Thana in Maharashtra and North Kanara (where it is grown as an inter-crop between betel-vines and spices. High yields are also reported from Hooghly district and Chandranagore in Bengal and Hajipur in North Bihar.

AREA UNDER BANANA IN INDIA

	(in acres)		*(in acres)*
Kerala	100,000	Andhra Pradesh	32,000
Madras	92,000	Gujarat	25,000
Maharashtra	60,000	Bihar	15,000
Assam	50,000	Orissa	27,000
Mysore	45,000	Others	18,000
		Total:	464,000

Climate and Soil

Banana plants can be seen growing from the southern tip of India up to a height of a few thousand feet in the Himalayas. However, banana is essentially a tropical plant requiring a warm humid climate. It grows successfully at elevations up to 2,500 feet in Assam and varieties like Sirumalai and Virupakshi grow successfully at altitudes up to 5,000 feet in South India. In warm dry weather, the fruit stops growth and in the cold weather it is damaged by frost. It stops growth at temperatures below 50°F. Some varieties can withstand the cold better. Monthan is often grown in North India in sheltered positions in kitchen-gardens. Rajapuri or Walha seems to be able to resist cold weather better than most other varieties. Tall varieties like Harichhaal can withstand cold weather better than Basrai Dwarf, but they make poor growth away from the coast. Basrai is affected by the cold even if the minimum temperature remains 40°-45°F for about a week. Sometimes frost even for short durations kills the plants even in the regular banana-growing areas. Such was the case in the Central Deccan area in 1925, 1929 and 1934, when the temperature went down to 32°-35°F.

Taller varieties like Harichhaal and Red Banana seem especially to require the warm moist climate of the coastal areas. In fact, a great deal of banana cultivation in India is located close to the coastal areas. Dwarf varieties like Basrai and Rajapuri grow successfully in dry interior areas like East Khandesh in Maharashtra with good irrigation. These dwarf varieties also escape damage from winds. Cyclones often do much damage to banana in South India. Provision of permanent wind-breaks or temporary ones of *Sesbania aegyptiaca*, etc., or even protection with dry stems of *tur* (*Cajanus cajans*) are helpful in preventing this damage from dry winds.

Seventy to 80 inches of rain, well distributed throughout the year is desirable for banana, but it can stand rain up to 150 inches. Stagnation of water is injurious and may cause diseases like Panama wilt. Under heavy rainfall, the field should be trenched to drain off the excess water quickly.

Banana is a voracious feeder and requires a rich, well-drained soil with plentiful organic matter. Even though it requires heavy irrigation, it cannot withstand water stagnation. The soil should, therefore, be well drained and at least three feet deep. It grows successfully in loamy soils of the wet paddylands, well-drained clay soils of delta tracts of the Krishna and the Godavari, irrigated medium-black soils of Khandesh and light coastal soils of North Kanara, Bassein, etc. The production in heavy soils is not as good as that in lighter soils. Lime in the soil is good for banana and alkaline soils improve under banana cultivation on account of the addition of organic matter necessary for banana. However, salinity above 0.05 per cent is injurious and the calcareous soils in the interior of the Deccan are too poor for banana.

Varieties

Many varieties of banana are grown in India, but the Champa, Poovan or Lal Velchi predominates. It occupies under 50 per cent of the total area. The varieties have a wide climatic adaptability and most of them are grown in several States. Many synonyms, therefore, exist. In the centres of consumption of North India,

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there is a demand only for varieties like Basrai with soft, sweet, non-starchy, aromatic, non-acidic pulp, but in the South and in Western India varieties like Rasthali and Raja Bale with firm, slightly acidic pulp are favourites.

Poovan: (Champa, Lal Velchi, Karpur Chakrakeli, Chinni Champa). It is important in all banana-growing areas of India, except the interior areas of Maharashtra. It is a hardy, high-yielding variety with a good keeping quality. The fingers are small, yellow, with firm sourish flesh. The bunch is large, weighs about 50 lb. and has 220 fingers.

Mortaman (Rasthali, Mutheli, Sonkel): The fruit is similar to that of Poovan in appearance, but of a much better quality. It is considered to be one of the best table varieties. The bunch is smaller, having about 130 fingers. The fingers on a bunch ripen gradually, but drop off easily.

Basrai (Vamankeli, Kabuli, Bhusaval, Mauritius, Jahaji, Pacha Vazhai, or Hirvi): It is a dwarf variety suited for cultivation in dry interior windy areas under irrigation. It is susceptible to injury from cold and is grown mostly in East Khandesh for export to North India, where it is sold under the name Chittidar. A bunch contains about 130 fingers of large size, sweet acidless taste, no traces of starch in the ripe fruit, and greenish yellow colour. Fruit ripened at a high temperature often develops black spots on it, hence the name Chittidar. The fingers are slightly curved and the bunch is rather lax. Its yield is high, but the keeping quality is poor. The fingers tend to drop off from the bunch when ripe. It does not bear fertile male flowers, is resistant to Panama wilt, but suffers from the bunchy top disease.

Harichhaal (Bombay Green, Malbhog, Sapri, or Pedda Pacha Arati.): It is similar to Basrai, except that the fruit is more green and straight, the bunch more symmetrical and the plant taller. It prefers a moist coastal climate.

Nendran (Rajeli): This is a dual-purpose variety of great importance in Kerala. The fingers are long, angular, prominently tapering and retain some starch even on ripening. It is used as fresh fruit, for cooking, for making banana flour, banana chips and for drying as banana figs. The keeping quality of the fruit is very good. The bunch is lax and very small. The variety is unstable and produces many variations of the parental form. Among these are included Nana Nendran, Myndoli and Attu Nendran. They thrive only in a moist climate.

Monthan. It is a small, stout, straight and angular banana. It is essentially used for cooking, but can also be eaten fresh. The keeping quality is good. It can withstand some cold and is found growing in sheltered places in U.P.

Other important varieties are Chakrakeli or Rajabale, with excellent fruit quality, but poor keeping quality and climatically not very adaptable, excellent hill bananas called Mala Vazhai (Sirumalai, Virupakshi, Vannan and Rajapuri, the fruit of which can be dried), Alpan of Bihar, Red Banana (Lalkel or Chen Kadali), Palankodan of Malabar and Safed Velchi or Ney Poovan. The fruits of the Safed Velchi are thin, small, with papery peel, good keeping quality and good fruit quality except that the pulp is dry. Other cooking plantains are Bontha and Batheesa, which bears only female flowers, resulting in a very long tapering bunch on which the fingers at the base are full grown when those at the apex are just starting growth.

PLANTING AND AFTER-CARE

The banana has a reduced underground stem, called the rhizome, which bears several buds. Each of these buds sprouts and forms its own pseudostem and a new bulbous rhizome. These daughter-plants are called suckers, and are used for raising new plantations. Each pseudostem fruits only once and is cut back after fruiting. New stems (suckers) arising from the rhizome take its place for fruiting in subsequent years. A plantation is generally kept for three years. However, under certain conditions the plantation is retained for five to 10 years without replanting. Such is the case with Mala Vazhai planted on rainy hill-slopes in South India and Poovan and Monthan on the deep rich delta-lands around Tanjore. On the other hand, Basrai planted in the dry irrigated areas of East Khandesh is pulled out after one fruiting season. Two types of suckers arise from the rhizome. One is the water sucker with large leaves and the other is the sword sucker with thin leaves and a pseudostem with thin base and pointed top. The latter is used for planting. They take a little longer to bear fruit, but the bunches are large and the yield higher. The suckers are detached along with their bulbous base from the parent-rhizome. The suckers should be under three feet in height. Larger suckers will bear fruit earlier, but their yield is lower. All their leaves and roots are removed and generally two-thirds of their pseudostem is cut off. New roots appear in about a week after planting. In South India the suckers are often kept in the sun till they wither and harden. In Western India they are dipped in diluted cowdung and then smeared with wood ash. These practices are followed to protect them from drying out in the field. In the variety Basrai in East Khandesh, the pseudostems are cut off after harvesting. Many suckers arise from the rhizome after this. The suckers are dug out along with their new bulbous rhizomes. The pseudostem of the suckers is cut off close to the bulb. These bulbs weighing about one to two pounds are stored in a cool dry place for about two months. During this period the leaf bases of the pseudostem drop off, exposing a raised heart bud. Bulbs with a small heart bud and a flat top are rejected. These bulbs are planted with the heart bud pointing up. In some countries, pieces of the parent-rhizome are also used for propagation, but this practice is not followed in India.

The planting is done generally in the beginning of the South-West monsoon. In later planting, the growth of the plants is checked by the onset of the cool weather. In Bengal the yield is poor if planting is delayed till the end of the monsoon. Planting can be done at almost any time in the South, where there is no cold weather. The planting is done in September-October at the end of the South-West monsoon in Malabar, in December in Travancore, in February-March on the hill-slopes of South India with a high rainfall and in April in the wetlands on the banks of the Kaveri river. In the coastal area of Greater Bombay, planting is done in April, June, August or October.

Planting is done in previously-dug and filled pits about 1′×1′×1′. The size of the pits is increased to 1½′×1½′×1½′ in heavy clay soils. The site for banana-planting should not be windy and windbreaks should be provided. In the interior areas, a temporary wind break of *Sesbania grandiflora* or jantar or shevri (*Sesbania aegyptiaca*) is provided on the windy side, 15 feet away from the banana plants. The land is cultivated deep several times before planting. In the Bombay area, brushwood is sometimes burnt in the fields in May to heat the soil. The land is manured early before planting, using up to 50 tons of farmyard manure per acre. Manure (5-10 lb. per pit) is sometimes added directly to the pits before filling them.

Banana is sometimes planted as an inter-crop betwen arecanut and coconut or as a shade plant for coffee and oranges in Malabar and the adjoining areas. In Gujarat, it is also planted between young mango trees to provide shade. Whereas in some other countries a planting distance of up to 20 feet is adopted, in India the plants are generally spaced seven to eight feet apart in both directions. The spacing varies greatly according to the variety and climate. The variety Basrai is planted four feet apart in the dry, irrigated areas of East Khandesh, where plant growth is less and yields of up to 40 tons per acre are obtained. The Red Banana in the Bassein area, the perennial plantations of Poovan and Monthan in the highlands in the Kaveri delta and the Mala Vazhai planted on the rainy hills in South India are planted 11 feet apart, since the plants grow very large in these places.

Planting is done either on flat land or in trenches, which are later filled up by interculture. The basal portion of the suckers is covered with soil, which is packed firmly and irrigated after planting. The dormant bulbs of Basrai variety are planted shallow in the loose surface soil. After planting one or two irrigations may be given about four to five days apart. When the suckers sprout, the land is cultivated and in some cases earthing-up of the plants done. This is especially important in the shallow-planted dormant bulbs of Basrai. In this case, earthing-up is required several times. After the rains, trenches are formed between the rows of banana plants for irrigation. Banana requires very large amounts of water. After the rainy season from October to February, irrigation is required every week to 10 or even 15 days, and every 5 to 8 days from March to May. The practice of irrigating every alternate day from February to June in Cochin is too excessive. In Bihar irrigation every 10 days from December to June is sufficient. Trenching requires more water but gives higher yield and larger fruits. In most inland areas, banana requires 40 to 50 irrigations from the time of planting to harvesting. In North Gujarat and East Khandesh as many as 90 irrigations may be required. In the perennial plantations of Poovan and Monthan in the Tanjore area two-foot wide and 1½-foot wide trenches are dug between alternate rows of plants. During the rains they serve to drain off excessive water and afterwards as irrigation channels. In the hilly areas and coastal areas no irrigation is ever required. During the periods of water scarcity the soil is covered with mulch of banana leaves. In rare cases, hand-watering has to be done in places like Bassein.

Banana requires heavy manuring near the surface of the soil on account of its shallow roots. Green-manuring the field before planting banana is desirable. There are several specialised systems of banana cultivation in different parts of India and the amounts and types of fertilizers used in these areas differ. However, unlike the mango-grower, every banana-grower realises the need for manuring. Quick growth during the first three months to get the largest leaf area is important for a high yield. Top-dressing with manure after six months is not desirable. Application of nitrogen hastens maturity and increases yield. Sometimes the growers go to uneconomical lengths to get early crops. Such is the case in Kerala, where growers often try to get a crop of Nendran bananas at the time of the Onam festival. In India the application of potash has not been found beneficial. The dose of fertilizers depends upon the climate, the variety and the soil. In most parts of India, about 0.5 lb. of nitrogen per plant is sufficient, except in Bihar, where 1 lb. of nitrogen, 0.27 lb. phosphorus and 2 lb. of potassium have been recommended. It is best to apply the nitrogen half in the form of organic fertilizers and half in the chemical

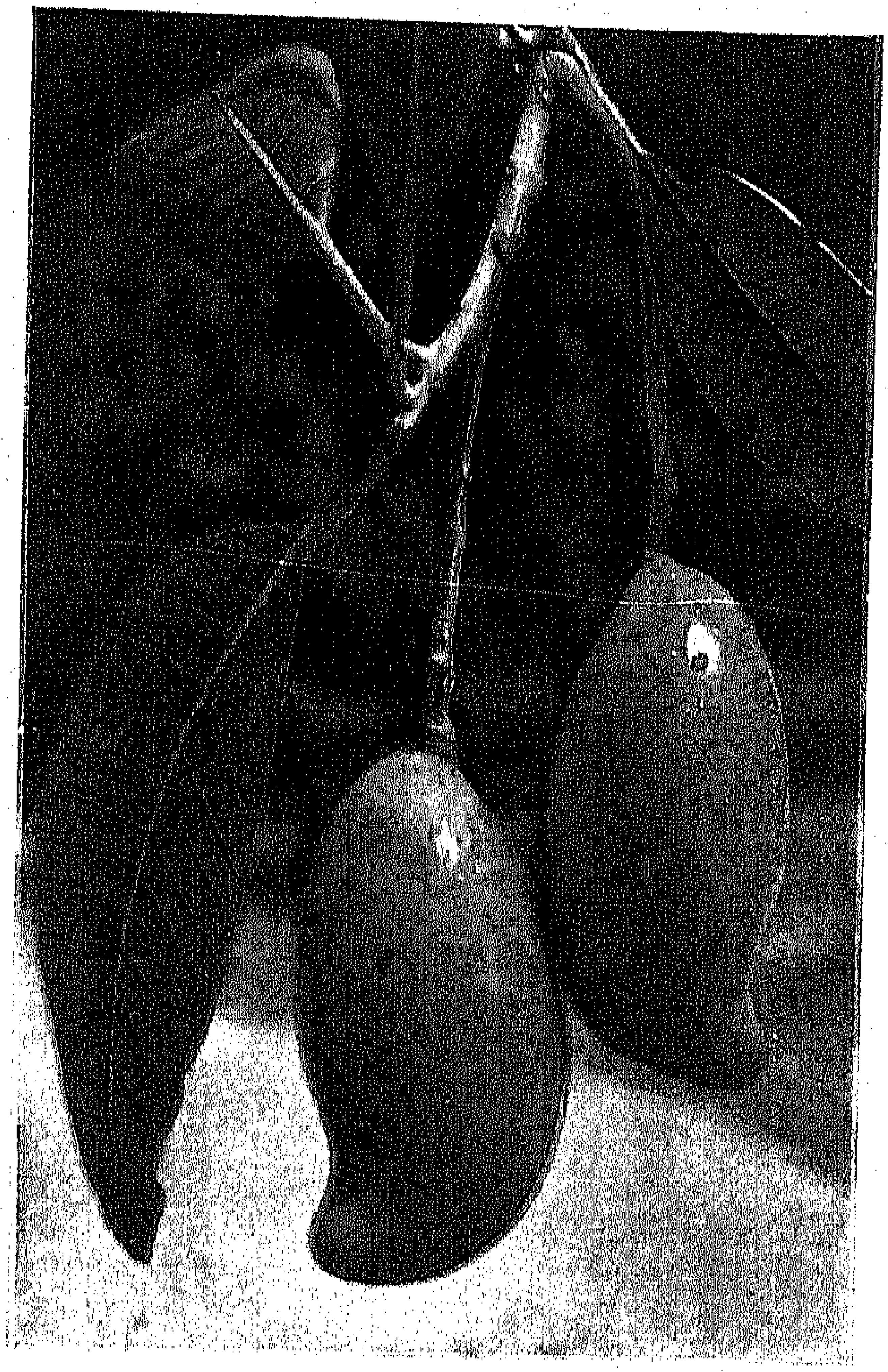


Plate I. MANGO VARIETY TOTAPARI (*Mangifera indica*)
(*page 24*)

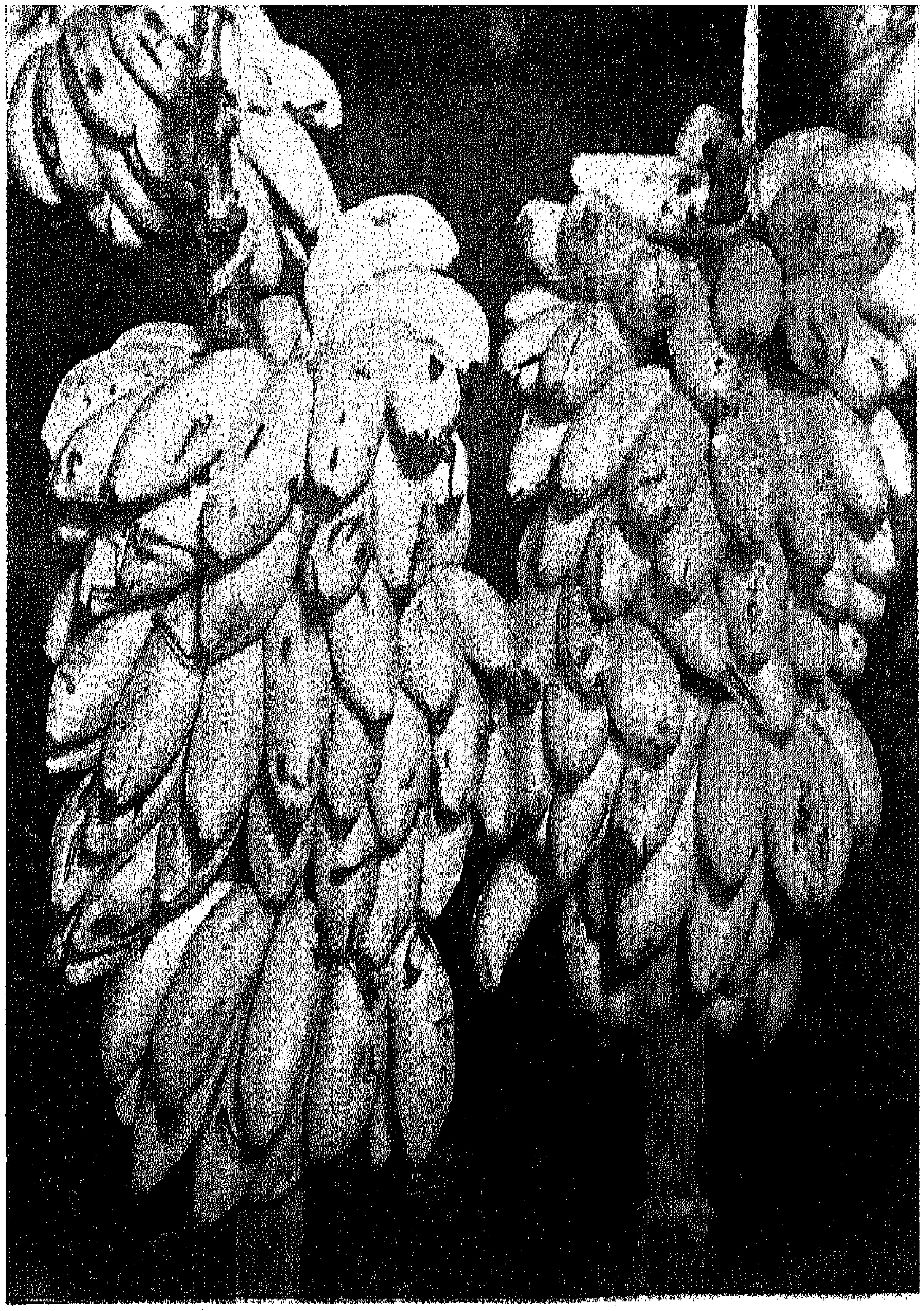


Plate II. MORTAMAN OR RASTHALI VARIETY OF BANANA (*Musa paradisiaca*) (*page* 52)

Plate III. KAULA MANDARIN (*Citrus reticulata*) (*page* 71)

Plate IV. Lucknow-49 Variety of Guava (*Psidium guajava*)
(*page 87*)

form. In East Khandesh two applications of groundnut cake at the rate of two tons per acre are recommended for the variety Basrai. Some of the cake can be replaced by ammonium sulphate. Alternatively, a basal dressing of 40 lb. of farmyard manure followed by 5 lb. castor cake split into three monthly doses per plant may be applied. Application of 80 lb. of farmyard manure alone is also done. In the Bombay area three applications of 4 lb. of castor cake each for every plant at monthly intervals have been recommended for the Lal Velchi variety. In Bassein three or four monthly applications consisting of castor cake 4-5 lb., ammonium sulphate 1½ lb., sulphate of potash 10 oz. and superphosphate 11 oz. per plant are recommended. Where the banana is rotated with betel-vine, which is manured very heavily, no basal dressing of manure is given. Three applications of castor cake at monthly intervals are, however, made. In the paddylands of South India, 1,500 lb. of groundnut cake or 40 cart-loads of farmyard manure per acre are considered sufficient. A basal dressing of 20 lb. farmyard manure plus three pounds of groundnut cake and 1 lb. of ammonium sulphate per plant in two doses as top-dressing is also applied. Heavier manuring is practised in the Kaveri delta. It consists of 224 lb. of ammonium sulphate per acre in April-May, two months after planting, repeated after another three months and again after three months. The second application also includes 1000 lb. of groundnut cake. In Kerala, a heavy basal dressing of farmyard manure is followed by the application of dry leaves and ashes about a month later. After another three weeks in May, with the break of the monsoon, 1 lb. of oil cake mixed with wood ash is applied. If there is a danger of an attack of the rhinoceros beetle, cattle manure is not given. A handful of ash is added to each pit before planting. When the plants have put forth three or four leaves, they are given 20 lb. of green forest leaves and 5 lb. of wood ash. After another three months a larger dose of these is applied again. In the Tanjore area of Madras State, 50 lb. of farmyard manure per clump is often given before the end of June. In Bengal, the variety Kabuli is given 30 lb. of silt, 2 lb. of mustard cake and 8 oz. of ammonium sulphate per plant at the time of planting and again four months later. On the hill slopes, the perennial banana plantations are frequently hoed and weeded and dry leaves, chopped old banana pseudostems and leaves mixed into the soil. No other manure is given. In places where sewage water is used for irrigation, no manuring is done.

The banana rhizome produces many suckers continuously. These compete with fruiting and should be removed. In a ratoon crop at the time of first flowering, there should be one half-grown sucker and another almost beginning to grow for subsequent fruiting. The last crop should have one sucker per plant for renewing the plantation. Where the plantation of Basrai is uprooted after one fruiting, the suckers are allowed to form only after the fruit and the pseudostem have been removed. To ensure that the suckers do not sprout again, they are severed close to the rhizome without damaging it. In South India, a crowbar with a chisel-like end is used for this purpose. Plants generally lean with the weight of the bunch on one side and become liable to be blown off. In windy locations, the plants are propped up with bamboos. After all the female flowers, which bear fruit, are finished, the remaining flowering stalk with the male flowers is cut off. Regular weeding is important during the first four months. Green-manuring with sunn hemp, etc., is also practised at this stage. About two or three old dry leaves should be allowed to hang on on the pseudostem to protect it from the sun. Other dead leaves should be cut off. The banana bunch can also be damaged by the sun in dry areas and needs protection. The red-coloured large bracts at the base of the immature banana bunch are turned back and tied over the stalk of the bunch. The bunch is tied over with banana leaves. This gives adequate protection from the sun.

As a general rule, a banana plantation is retained to give three crops in India. In the interior dry climates, the plants seem to deteriorate soon. They give a poor yield and small fruits in the second year. Such is the case with the variety Basrai in East Khandesh, where it is uprooted after one crop. The same variety under the name Kabuli in the wet climate of Bengal gives three

crops. In the moist climate along the Western coast of India, banana is generally grown as a rain-fed perennial crop among the plantations of coconut, areca-nut, jack-fruit and mango. However, some varieties like Nendran in Malabar and Red Banana along the Bombay coast have to be replanted in fresh land after one crop. Hill bananas are also grown as a perennial crop. This is the case with the cultivation of Sirumalai and Virupakshi varieties in the hilly areas of South India. The hill banana of Bombay area, the Rajapuri, is cultivated for about 10 years. In the delta lands in South India, which are very fertile due to deposits of silt from the flood waters of rivers, the plantations are often perennial. Such is the case with the cultivation of Poovan and Monthan in the Tanjore area and Rasthali and Kunnan in the delta of the Godavari river. In other places in South India, the plantation is retained for three to five generations. The last generation is often used only for raising leaves which are used as plates for meals.

HARVESTING AND HANDLING

Like mango the banana is also harvested raw and ripened artificially. The fruit is harvested after the fingers begin to turn light green and the ridges on their surface change from angular to rounded. The top leaves at this stage begin to dry up and the dried remains of flowers at the end of the fruits drop off easily. The banana takes nine months to a year to flower for the first time and at least another three months to mature the fruit. Subsequent fruiting in the same plantation takes place after another six to ten months. In South India banana can be had almost all through the year, but the main banana season all over India is September to April. During the hot dry months, the fruit is not available. The entire bunch is harvested with at least one-foot-long stalk, which acts as a handle. Smearing the cut end of the stalk of bunch with vaseline is recommended. The pseudostem which bore the bunch is also cut off at this stage. Some authorities recommend that this cutting may be done in two or three instalments. The bunch should be protected from sun and rain after harvesting and handled gently. Bruised fruits turn black afterwards. In places around Bombay, the bunches are wrapped with banana leaves, but the bulk of the fruit is handled unwrapped. The variety Basrai grown in East Khandesh is packed loose in steel railway wagons with banana leaves spread between each layer of bunches. The fruit of even this delicate variety reaches Delhi in good condition after 48 hours. In Delhi it is auctioned and again loaded in trucks for despatch to smaller towns. The fruit transported in the south in river boats receives little better handling.

The yield varies greatly according to the locality and the variety. The average yield in the country is about 10 tons per acre and is very good by world standards. Some varieties like Basrai in East Khandesh and Poovan in the Tanjore area in Madras give yields of 15 to 20 tons per acre. Yields of even 40 tons per acre are obtained. However, in Mysore, in rain-fed areas like Kerala and the hill bananas grown on slopy lands in the south, the yield is much lower, being about 2 or 2.5 tons per acre. In areas with high yields, banana cultivation is very profitable. It may not be able to compete with apple cultivation in point of high income, but a net income of Rs. 2000 per acre is not uncommon.

Banana is commonly ripened in a closed room with smoke, but it can also be ripened at room temperature. It is a common sight in South India to see banana bunches hung from ropes in shops. The fingers are sold as they ripen. This method works especially well in varieties like Mortaman or Rasthali in which all the fingers in a bunch do not ripen at the same time. Insertion of a little garlic into the cut end of the stalk of the bunch is said to hasten ripening. In a closed atmosphere the moist heat and the ethylene gas generated by the ripening fruit hasten the ripening of other fingers, which are slow in ripening. The whole bunch thus ripens more uniformly. For ripening, the bananas are heaped in a store, which is filled to two-thirds its capacity. The heap of bananas is covered with a layer of leaves and cowdung. Fire is built in one corner of the room. The room is closed and all chinks and holes in the doors are covered with mud plaster. The fruit is taken out after about 24 hours in summer and 48 hours in winter. In some places the hands of banana are separated from the bunches, heaped, covered with

banana leaves and then mud-plastered. At the bottom of the heap on one side, an earthen pot with holes in it is so placed that its mouth is open and the rest buried in the bananas. A fire is built in the pot for 48 hours. It may have to be re-ignited two or three times. The smoke enters the banana heap through the holes in the pot and ripens the fruit. The fruit is pale yellow at this stage and turns yellow in another two or three days in the open atmosphere. The smoke created by the fire seems to have no value in the ripening and only the moist heat hastens the process. In fact, bananas ripen much better in cold storage. They can be stored at a temperature slightly above 55°F and a relative humidity of 85 to 95 per cent for about three weeks, and ripened in a week or two at 62°-70°F. Fruit ripened at this temperature has a uniform, attractive yellow colour and does not have black spots found on fruit ripened at higher temperatures. In summer these spots are small and round and in winter they are larger, irregular black patches. Banana fruit is chilled and becomes blackened at lower temperatures and should not be placed in a refrigerator.

DISEASES AND PESTS

Fortunately banana suffers from only a few diseases and pests in India and these are not very serious. The dreaded Panama wilt disease, which threatens the banana industry in tropical America, is not serious here.

Bunchy top: This is the most serious disease of banana in India. It was first reported in Orissa in 1939, and spread to other parts rapidly. It is caused by a virus. None of the Indian varieties is resistant to it. The variety Basrai or Vaman Keli is most susceptible to it and Poovan is also susceptible in South India. It is serious in East Khandesh, Kerala and Assam. The leaves on the affected plants are bunched together into a rosette at the top and their margins are wavy and slightly rolled upwards. The basal part of the leaf shows dark green lines consisting of dashes and dots along the midrib. It is spread by an aphid (*Pentalonia nigronervosa*), which is hard to kill. There is no cure and the affected plants should be sprayed with kerosene oil to kill the aphids and then destroyed to prevent its spread to other plants. Suckers should not be obtained from affected areas.

Panama wilt: This disease caused by the fungus *Fusarium oxysporum* var. *cubense* is dreaded in tropical America, where the famous variety Gros Michel is grown almost exclusively, but our main varieties are free from it. Basrai is immune and Poovan resistant, but Sonkel or Rasthali, Malbhog and Alpan are very susceptible, and Sirumalai also susceptible. It is serious only in poorly-drained soils. The leaves turn yellow from the margins and dry up. The oldest leaf is affected first and the youngest last. The fruits become bottle-shaped, and the vascular tissues become discoloured. Suckers from affected rhizomes remain stunted and should not be used at all. The affected plants should be uprooted and burnt. The fungus also lives in the soil. So the soil around the affected plants should be mixed with quicklime and soaked with water. Suckers should be obtained from disease-free plants. After uprooting the infested plantations, banana should not be grown in the same field for some years.

Main stalk rot: This is caused by a fungus (*Gloeosporium musarum*) and is also called anthracnose. It starts on the bent portion of the fruiting stalk as a blackish area with cracks and spreads to the immature fruit. The pulp of the mature fruit is dry and discoloured. Only bunches exposed to the sun get this disease. Keeping the stalk and the fruit covered with dry banana leaves saves it from the disease. Spraying the young fruits with Burgundy mixture or Bordeaux mixture is recommended for prophylaxis. Washing the fruits in the antibiotic Mycostratin is beneficial.

Cercospora leaf spot: This is very serious in tropical America, but not in India. The causal fungus destroys the leaves. It has been reported to be serious in Assam. The variety Basrai is especially susceptible to it. Mineral oil sprays are effective against it.

Banana stem weevil: Two species of insects, *Cosmopolites sordidus* and *Odiporus longicollis*, which eat into the underground rhizome of the banana from April to October, are the most serious pests in Kerala, Madras, Orissa and Mysore. The variety Malbhog is

especially susceptible in water-logged conditions. Application of a spray of aldrin 0.05%, 0.16% DDT or 0.05% BHC to the soil around the plant has been recommended. Aerial spray of DDT has also been suggested. However, their effectiveness is limited since the grubs live inside the rhizomes. A practical remedy is to burn the infested rhizomes and plant banana in a new well-drained soil with healthy suckers.

Leaf and Fruit Beetle: Nodostoma Subcostatum, which chews the fruit and the leaves seriously from August to September, is also important from Assam to U.P. Alpan, Champa and Malbhog varieties are especially susceptible. It can be controlled by clean cultivation and spraying of DDT or BHC.

CHAPTER IV

CITRUS FRUITS

Citrus consists of a group of fruits belonging to the family Rutaceae, to which belong the *bael* (*Aegle marmelos*), wood-apple (*Feronia limonia*) and the ornamental shrub Kamini (*Murraya paniculata*) with sweet-smelling flowers. The special feature of citrus fruits is the presence of juice sacs in them. Unlike most other fruits, they lack a firm pulp and are either sucked or made into beverages. They may not be able to match the appeal of Dasheri or Alphonso mango or the energy-giving qualities of a banana, but they have a place of their own. There is hardly anything to replace a glass of orange juice on a hot June afternoon or the appeal of an orange after a meal. They are a rich source of vitamin C. The citrus fruits also contain vitamin P, which keeps the small blood vessels in our bodies in a healthy condition and helps in the assimilation of vitamin C. Tablets of vitamin C prescribed by the physicians are, therefore, not as effective in relieving the deficiency of this vitamin as much as fresh citrus fruits are. It is interesting to note that the richest sources of vitamin C, the Barbados cherry and the *aonla* (*Emblica officinalis*) also belong to families which are botanically very closely related to the family of the citrus fruits. The only other fruit rich in vitamin C is guava, which does not belong to this group.

There are many kinds of citrus fruits found in the world. These breed with each other in nature freely and new types are coming up from time to time. In India a rich array of these types is found growing semi-wild. Most of these are indigenous to India and have originated in the Assam area. They grow wild in the sub-montane areas. The most important among these is the rough lemon, "Jambhiri", "Jamburi", "Khatti" or "Jatti Khatti" (*Citrus jambhiri*). It is the commonest root-stock in India. The other indigenous species are Satkara (*C. macroptera* var. *annamensis*), *Citrus indica* and Ada Jamir found in Assam, *gajanimma* (*C. pennivesiculata*) and Kichili (*C. maderaspatana*) found in South India and amilbed (*C. megaloxycarpa*) and hill lemon, galgal, Biharee nimbu or paharee nimbu (*C. pseudolimon*) found at the foot of the Himalayas. About amilbed, Emperor Babar has said that it is so sour that it would dissolve a needle thrust in its pulp! This, of course, is a great exaggeration. Two other species found growing semi-wild are pummelo and citron, but these are not indigenous to India. The pummelo has the largest citrus fruits and produces the largest trees among the citrus group in heavy rainfall areas around Sikkim and Nepal. It seems to have been introduced at a very early age. Its Indian names Chokotra, which corresponds to Jakarta, and Batabi, which is a modification of *Batavia*, suggest its introduction from Java. The other fruit, citron, mokri or turanj, is found even more commonly all over India. It is considered by some people to have originated in India. However, there are indications that it originated further west. Many forms intermediate between citron and lemon, which originated in eastern India, are found wild in India. These were probably confused for the true citron.

None of the above species is cultivated in India as a table fruit except the Kichili. The important commercial citrus fruits grown in India are definitely not indigenous to this country. The most important is the mandarin orange, santra, sangtra or Kamla orange (*Citrus reticulata*). This is a loose-skinned orange and is often erroneously called orange which, in the English language, denotes the tight-skinned orange (*C. sinensis*). The sangtra, as is suggested by its name mandarin, originated in South China. It is possible that it originated further south in Indo-China. It came to India in the beginning of the Christian era. It was probably brought from the east by the Shan people of China from Yunnan to Assam. In Babar's time it had not spread west of Bengal. However, at present it is the most important citrus fruit of India cultivated all over the country.

The sweet orange (*C. sinensis*) is also indigenous to China. It is believed to have been introduced into South India from where it was taken to the western world by Vasco da Gama in 1498. However, it did not spread in India. The present cultivated varieties are recent introductions from abroad. Indian names of some of its varieties like Mosambi (Mozambique), Malta and Batavian (found in South India) suggest their introduction from foreign countries. These have been introduced mostly from the west in the present century but one type, Soh-niangring, grows semi-wild in Assam and must have entered India from the east at a very early time.

The other important commercial fruits are the lemon and the kagzi or sour lime. These also are not indigenous to India, but have become well established here. Pickles of limes and lemons are popular all over India. They are also used daily for garnishing the meals, especially in fish-eating areas like Bengal. An ornamental citrus plant found in India is the Calamondin, China orange or Hazara (*C. madurensis* or *C. mitis*). It bears small ornamental fruits, which continue to hang on the tree for months. It is often raised in large pots. It is the same fruit as the Calamency orange of the Philippines which is used for flavouring tea in that country.

The era of growing citrus as a backyard plant has given rise to commercial plantations. The area under citrus has been increasing in spite of the threat of citrus decline and citrus canker. In India citrus occupies an area of .22 million acres out of the total area of 3.09 million acres under all fruits. The State-wise figures are given below:

AREA UNDER CITRUS IN DIFFERENT STATES

(Figures obtained from the Directorate of Economics and Statistics, Ministry of Food & Agriculture, Govt. of India)

State	*Area (acres)*
Maharashtra	59,000
Andhra Pradesh	57,000
Mysore	27,000
Assam	23,000
Madhya Pradesh	12,000
Gujarat	10,000
Kerala	5,000
Punjab	10,000
Madras	12,000
Tripura	5,000
Rajasthan	3,000
Total	225,000

It will be noticed that little citrus is grown in the plains of Bengal and Bihar, even though citrus cultivation in Assam is successful on the hills. In areas of high rainfall, the plants fall a prey to many diseases due to high humidity.

Mandarin (*C. reticulata*) is the most important commercial crop. It occupies about 39 per cent of the area under citrus. The chief centres of production are the Nagpur area, Assam and Coorg. The sweet orange comes next, occupying about 12 per cent of the area, Maharashtra, Andhra Pradesh, the Punjab and Rajasthan being its principal centres. The total citrus production is estimated at 823,680 tons. Hodgson, an American expert, estimated the following figures for production in 1961.

Mandarins	Approx.	10,000,000	boxes.
Sweet oranges	„	3,000,000	„
Sour limes	„	2,000,000	„
TOTAL:	„	15,000,000	„

The other fruits grown commercially are Kichili (*C. maderaspatana*) in Andhra Pradesh, sweet lime (*C. limettioides*) in the Punjab and Madras and pummelos (*C. grandis*) scattered all over the country.

Soil and Climate

The fact that citrus grows in all parts of a vast country like India clearly shows that it can thrive in a wide range of soil and climatic conditions. It grows in almost any soil. In the Nagpur area mandarins grow on heavy black soils, and in Assam they grow on sandy and gravelly hill-slopes. In Andhra Pradesh, the red laterite soils used for citrus are often very heavy. The alluvial soils of the Punjab range from light to heavy. The heavy soils of Nagpur are underlaid with a *murrum* layer, which provides a good drainage. The type of soil seems to be immaterial so long as sub-soil drainage is good. Under poor drainage, the soil becomes water-logged around the roots during heavy rains in the monsoon season even though the water-table may not be high. The failure of sweet orange in several places in the Punjab and U.P. seems to be due to this factor. The failure of citrus in many garden colonies in the Punjab is undoubtedly due to poorly-drained soils. Where the water-table is high and it also fluctuates, citrus has no chance. On the other hand, citrus does exceedingly well in sandy soils which are well-drained, provided sufficient nutrients are supplied to the plant. Such is the case in Florida in the U.S.A., where the soil is coarse sand, the water-table is at about four feet and fetilizers are applied almost every month. A moderate amount of lime in clayey soils makes them more friable and is good for citrus, but excess lime as found in the marl lands of the Deccan peninsula is poor in nutrients and toxic to oranges.

The climatic range tolerated by citrus is remarkable. It grows not only in the scorching dry plains of North India, but also on the cool hill-slopes of Sikkim and Darjeeling and in the tropical conditions of Madras State. The mandarin shows a wider range of adaptability with regard to rainfall and can tolerate cold weather better. It grows successfully from the Himalayan climate of Sikkim to warm dry places like Nagpur. In colder areas the fruit is puffy but its colour develops better. In Nagpur the fruit remains pale orange in colour. The rainfall in mandarin areas is around 30 inches in the plains and up to 100 inches on hill-slopes. In Coorg and adjoining areas where the mandarin grows at altitudes ranging from 2,000 to 3,000 feet, the temperature ranges from 48°F to 90°F, but in Nagpur the summer temperature goes above 105°F. However, in the hot summer temperatures the fruit gets sun-burnt. Mandarins, like lemons, ripen well during comparatively cool summers. Extreme cold and extreme heat are not desirable. Mandarins do best in an equable tropical climate with a cool summer. They thrive in the hilly areas of Assam, Darjeeling, Coorg, Wynad and the lower Nilgiri Hills without irrigation and in Nagpur in Central India with irrigation. They do not like the humid warm plains of South India and the hot plains of North India. The distribution of rainfall is also important. Heavy rain at the time of flowering after a long dry spell can cause excessive vegetative growth and poor flowering.

It has been observed that the sweet orange can stand a more humid climate than mandarin, but both are sweeter in a dry climate, if proper irrigation is available. In North India, where the minimum temperature in winter generally ranges from 35°F to 40°F, the trees not only get a proper rest period for flowering in spring, but the fruit also develops a good colour. The Musambi orange remains light yellow coloured in Maharashtra State, but when grown in North India it develops a bright reddish orange colour. In warm winter the red pigment in the pulp of blood oranges also does not develop. When a hedge of *Sesbania aegyptiaca* is grown on the south side of the trees to protect them from the heat of the sun, the blood colour improves considerably. The blood pigment can also be developed by storing the fruits for six weeks after harvest at temperatures from 32°F to 39°F.

The sweet orange prefers a more sub-tropical climate. It requires a warmer summer for ripening. However, it can be grown even in the plains of South India where winter is very mild.

The conditions prior to flowering are more important. Under North Indian conditions the different citrus species produce from three to five flushes of vegetative growth. Shoot-growth takes place between 56.5°F and 75.5°F and root-growth between 61°F and 82°F. Flower buds differentiate from January to March and the individual shoots show alternate bearing. The earlier vegetative flushes of the previous season generally are more productive.

Pummelo can stand more rainfall and does not thrive in dry regions. It thrives in submontane areas. Grape fruit on the other hand thrives best in the hot plains of North India. Here it makes better growth and develops better quality than any other citrus species. Sour lime grows in high rainfall as well as in drier climates.

Citrus is essentially a sub-tropical fruit. It is also a tender plant which is not able to survive in the truly wild form in jungles anywhere. Its mere survival in the plains of North India is a feat. Here it faces scorching dry heat and lack of moisture in May-June. Immediately afterwards it is exposed to high humidity and consequent diseases and pests and water-logging of soils in the monsoons.

In winter it has to face frosty nights. Under these conditions, its cultivation requires special care.

In North India citrus generally flowers in spring (March) and the crop matures in August-September in case of sweet lime (*C. limettioides*) and from November to February in others. However, as we travel south, the winter is too mild and regular flowering does not take place at one fixed time. In South India the seasons are less well-defined and longer. Flowering takes place several times in a year. Spring flowering takes place earlier in December to March. A second flowering takes place from September to November and a small third one from June to September. The crops from these flowers mature in November-March, June-November and March-June, respectively. In Central and Western India, the spring flowering in February called the *ambe bahar*, gives the main crop in November-December, the *mrig bahar* in July gives the second crop in March-May and *hatti bahar* in September-October gives a small third crop in July-August. The fruit of *mrig bahar* comes to the market when the demand is good. Its fruits being too raw and acidic during the rainy months also escape the attack of the fruit-sucking moth. It is also good for areas where there is scarcity of water in May-June, when the trees are given rest.

In Central India, in order to get one abundant crop instead of three poor ones, the trees are given a *bahar* treatment. Irrigation is withheld for two months before flowering. If the leaves of the trees do not wilt, as happens in heavy soils, the soil around the trees is removed up to a depth of five inches and the small roots are removed. After ten days, the soil is mixed with manure and put back. A light irrigation is given and is followed by a medium irrigation, after about seven days. Normal irrigation is given after another ten days. This ensures that the tree does not produce a sudden and heavy vegetative flush and encourages profuse flowering. The September-October flowering is not given this treatment since it does not respond to it well due to rains and also does not give a good crop. This practice is not followed in North India where it is not needed, and in South India, where its immediate effect is to increase the crop, but to decrease the vigour of the trees in the long run. *Bahar* treatment in South India is also made difficult due to frequent rains, which interfere with the rest period.

VARIETIES

In India the loose-skin oranges or mandarins are often called oranges and the sweet orange is called malta. This causes confusion since the English word orange refers to the sweet orange. Among mandarins, there are three important types—Coorg, Khasi and Nagpuri. The last is propagated as a budded plant and the other two as seedlings. They are all of the Ponkan type of China and their fruits and plants show little difference. The seedlings are more vigorous, spiny and erect. All three have an excellent fruit quality. The recent introductions include *Kinnow*, which is reported to be resistant to sun-burn and to have a richer juice. However, there are some misgivings about its productivity, even though demand for its plants is great. Other introduced varieties are Emperor and Fuetrells Early from Australia and Butwal from Nepal. The Laddu with small fruits, a vigorous tree and a good yield is grown to some extent in U.P. and the Deccan. It is cultivated in the Philippines, but is not so popular in India since the fruit is not as sweet as that of the other varieties. Srinagar and Hill mandarins are two varieties recommended for U.P.

The varieties of a species of citrus, unlike those of mango, are not easy to identify. Among the sweet oranges the most important variety is the Musambi from Maharashtra. It has a distinctive furrowed fruit, with a smooth circular areaole and juice with very low (.3%) acidity. It is similar in taste to the Succari orange of Egypt. Another variety, the origin of which is not known, is the Sathgudi or Chini of Andhra Pradesh. It has a good flavour, but does not develop a proper skin colour or flavour under the humid conditions of South India. A cultivar grown in the coastal areas of Andhra Pradesh is the Batavian. It is similar to the Sathgudi, but is said to be less sweet. This may be due to the fact that it is harvested very early to avoid damage from the fruit-sucking moth. Another feature of this variety is that each fruit is wrapped in a basket-like covering woven from palm leaves to protect it from the moth. The colour on the skin does not develop where the light is cut off and the fruit develops a chequered appearance. Among the recently-introduced varieties, Pineapple is most successful in the Punjab. Its fruit has a smooth deep bright orange skin, the pulp is highly flavoured and sweet and the yield good, but it has bold seeds. Another successful variety is Malta common, which is considered to be a mixture of varieties by some people. Joppa and Vanille are also good. Hamlin is popular due to its earliness, but it shows a high percentage of dry granulated fruits on the rough lemon root-stock. Valencia bears well but ripens too late in the season. It is usually harvested in the month of February along with other varieties, when it is still sour. It has, therefore, fallen into disrepute, because of its poor quality. Another important variety is Blood Red grown in the dry tracts of the Punjab and Rajasthan. Washington Navel develops a large fruit, which lacks both juice and quality.

Among sour limes (*C. aurantifolia*), there are no well-established varieties except the oval-fruited one from Assam called Abhyapuri lime. The fruits of ordinary varieties are roundish. Among lemons (*C. limon*) there are several varieties. The commonest in South India are Malta and Nepali oblong. Rajamundry and Kagzi Kalan or Baramasi are natural hybrids between limes and lemons. Amongh grape-fruits Marsh Seedless, also called Saharanpur Special in some places, Foster, Thompson and Duncan are popular. Among pummelos there are no established varieties, but considerable variation exists on account of monoembryony. Large or small, oval, round or oblate and white or red-fleshed types are found.

PROPAGATION AND ROOT-STOCKS

Mandarins are propagated as seedlings in Coorg and Assam, where they are grown in conditions of heavy rain. The seedling trees come to bearing late, but live longer. One-hundred-year-old healthy seedlings of mandarins can often be seen. The seedlings are more thorny as compared to budded plants. Sour limes are also propagated as seedlings very often. The delay in the age of

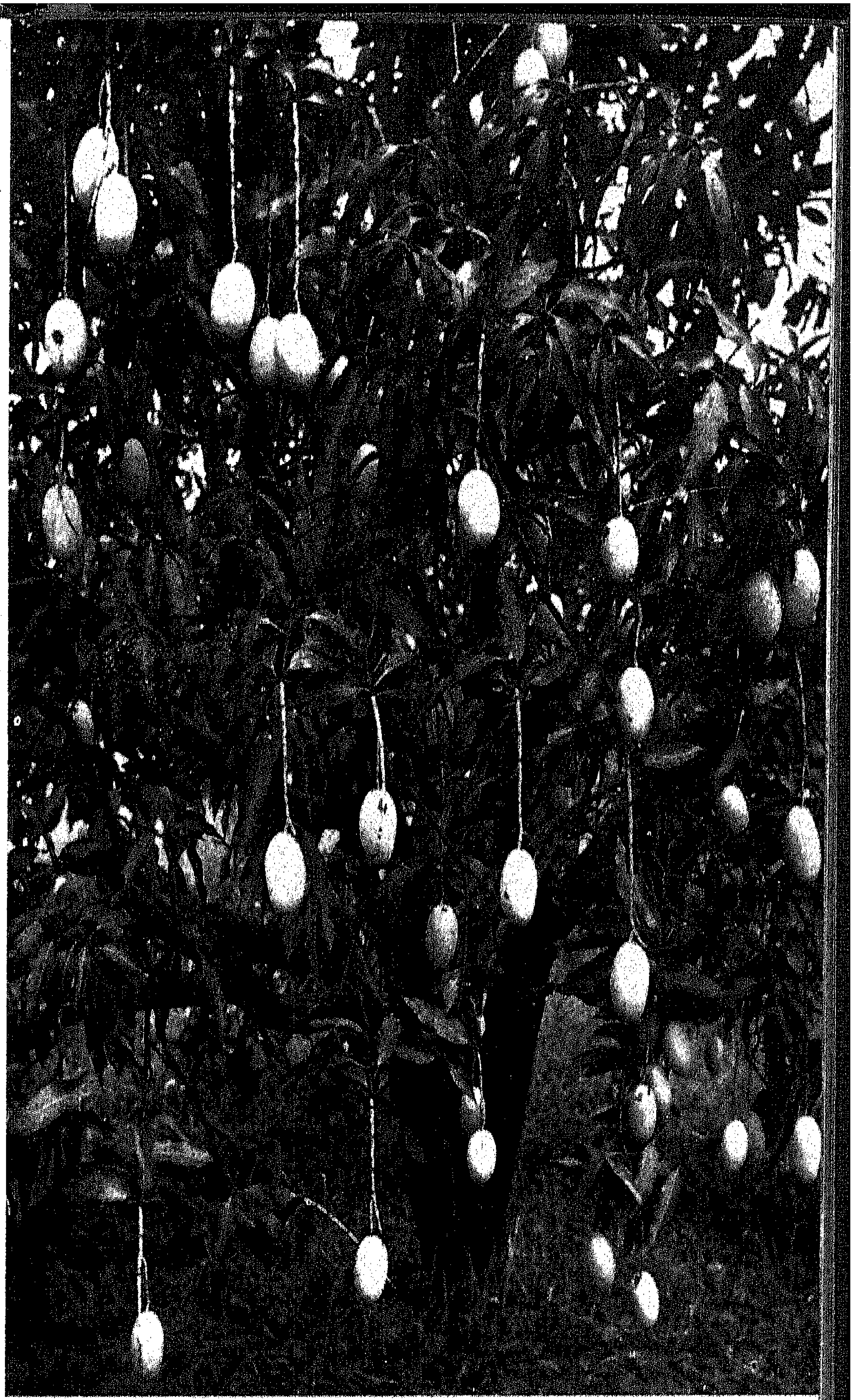


Plate 1. A TREE OF DASHERI MANGO (*Mangifera indica*)
(*page 25*)

Plate 2. A Sweet Orange or Malta (*Citrus sinensis*)
(*page 65*)

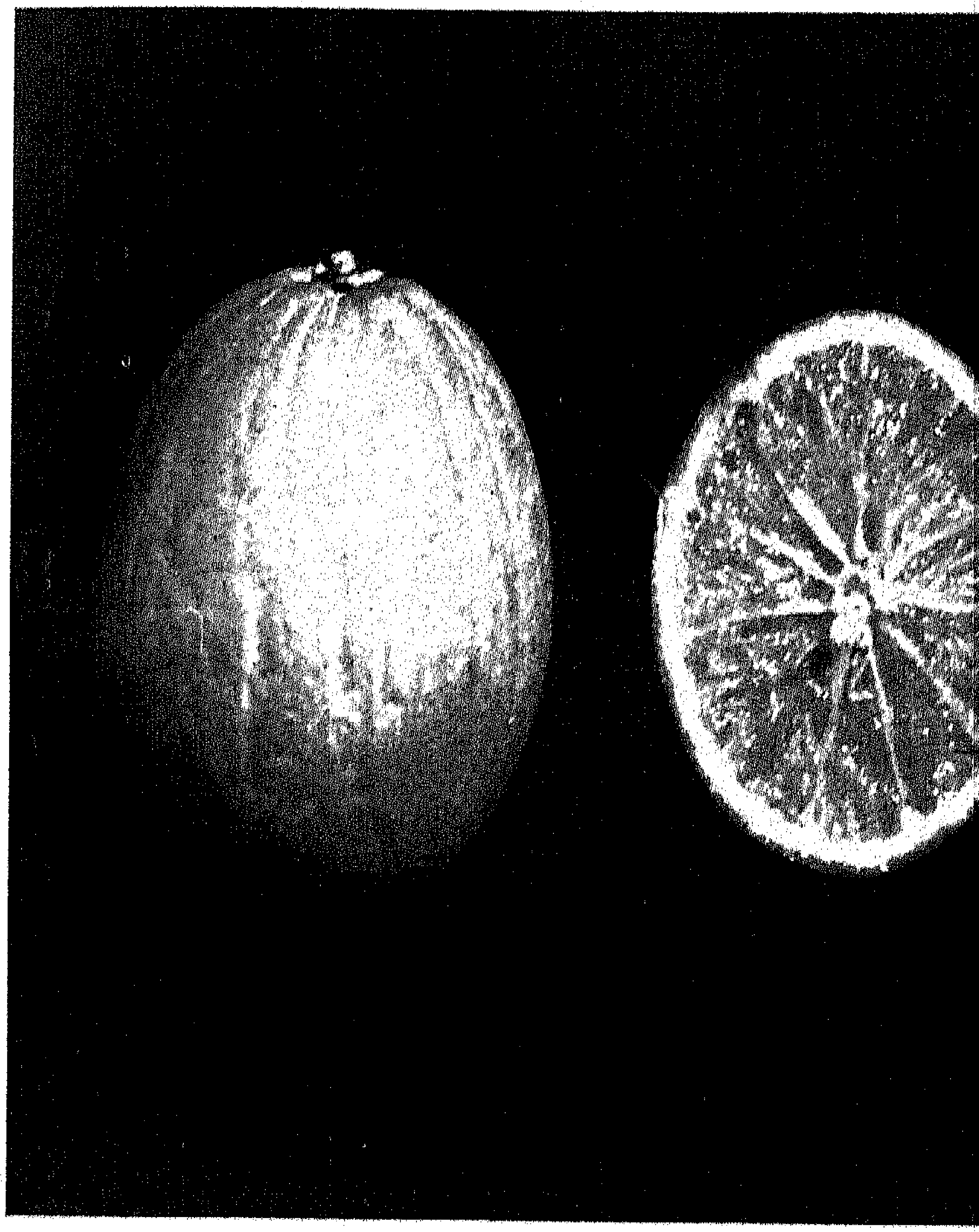


Plate 3. Musambi, Sweet Orange (*Citrus sinensis*)
(*page 69*)

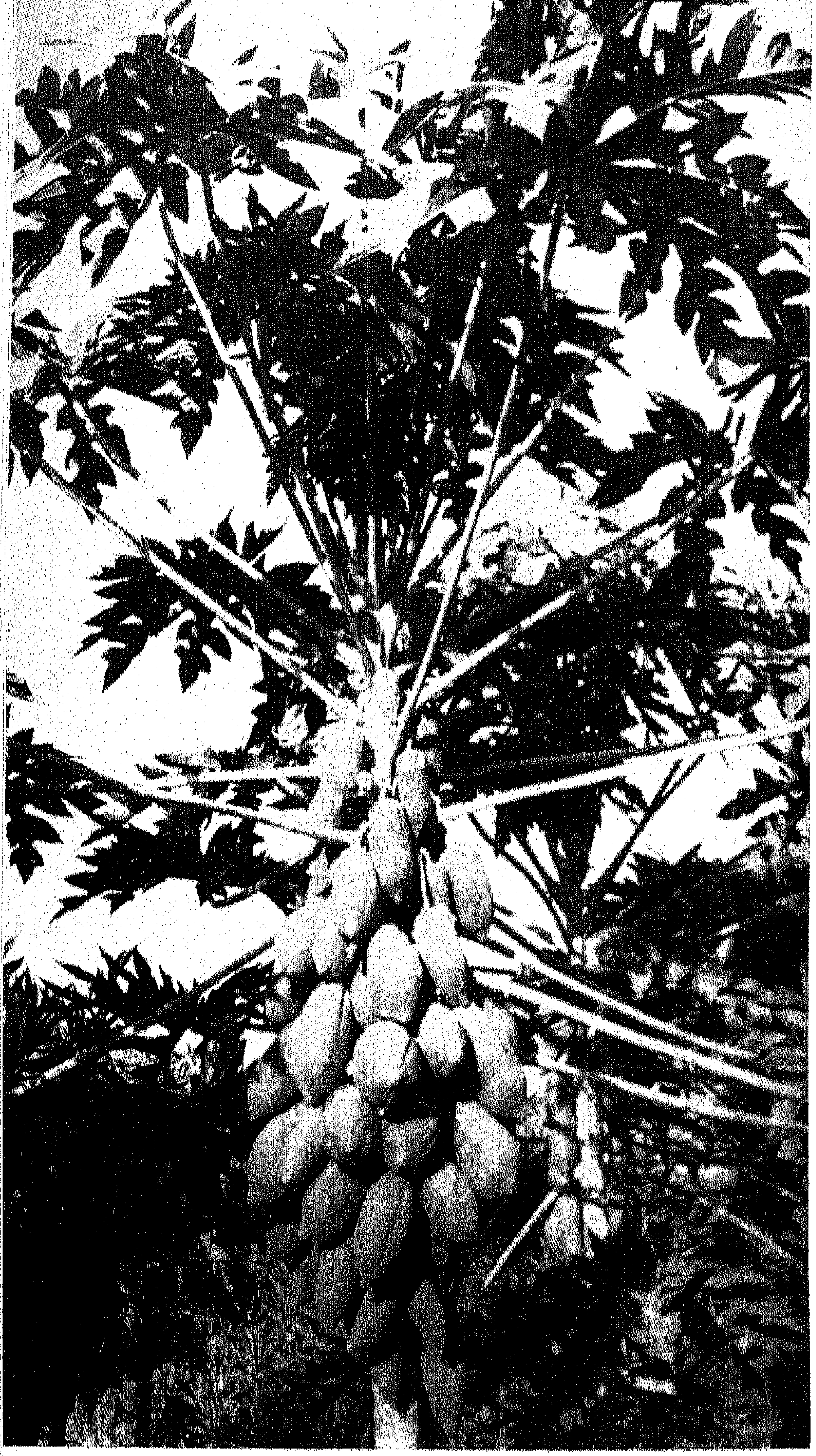


Plate 4. PAPAYA PLANT (*Carica papaya*) IN BEARING
(*page 91*)

bearing in this case is very little. The Sathgudi oranges in the Rayalaseema area are often raised as seedlings, which give more disease-resistant and longer-lived trees.

Sweet lime is generally propagated by layering or from hardwood cuttings. September is the best time for planting cuttings and the results are improved by treatment with Seradix A or IBA 500 ppm. In Assam air-layering of mandarin, sweet lime and Musambi gives success varying from 90 to 100 per cent. The commonest method of propagation, however, is T-budding which is a successful method all over the world. The seeds of citrus root-stocks lose their ability to germinate very soon and should be sown within two weeks from the date of extraction from the fruit. Seeds are ready for germination even before the fruit has changed its colour. Seeds are generally extracted and sown in August-September. In Central and South India, they are also sown in May-June. If sowing is delayed, the cold weather sets in and the germination is poor. Storage of seeds till spring reduces germination, which can be tested by the tetrazolium test. They are sown in raised seed-beds containing leaf-mould, one inch apart in rows spaced three inches apart. They start germination within three weeks and are transplanted at wider spacings at least twice. In the common root-stocks of citrus, several seedlings arise from each seed. One of these is the sexual seedling and it is generally weak. It should be discarded. All weak and overly vigorous seedlings are uprooted. Citrus plants being evergreen are generally transplanted with a ball of earth. However, under moist tropical conditions, they can be dug out with bare roots on a cool cloudy day. They are planted finally in beds and spaced 3′x1′ apart. All side-shoots arising within one foot of the ground are rubbed off to get a straight stem. The seedlings are ready for budding in about a year. The removal of wood from the bud in case of angular scions often damages the bud, and budding along with the chip of wood gives good results. In mandarin the removal of wood seems to decrease the percentage of success, but the budlings make better growth. In sour lime, the bud-take is more with the wood.

Budding is generally done either in spring or in August-September in North India. There is up to 85 per cent success in the budding of sweet orange in June. Budding in mid-winter or early in the rainy season is also advocated. In Western India, budding can be done at any time, when the plant is in active growth, which is normally in spring and the beginning of the rainy season. However, October to December is the best season here. In South India, July to September is the best time.

T-budding or shield-budding is easy to perform. The root-stock is generally budded at a height of about nine inches. Often the scion of the budded plants in the field comes in contact with the soil due to deep planting or flooding of the field. Soil-borne diseases can thus enter the scion, even though the root-stock is resistant to them. Budding at a greater height is, therefore, desirable. The root-stock is about the thickness of a lead pencil. Bud wood is chosen from the rounded basal portion of semi-mature shoots of the current season's growth. The leaf-blades are cut off, retaining the leaf-stalks around the buds. Angular bud wood is avoided. Two cuts are given in the bark of the stem of the root-stock at a proper height to form a T. The vertical cut of the T is about 1½ inches long and the horizontal cut goes about half-way around the stem of the root-stock. Flaps of bark in the crotch of the T are lifted with a knife on both sides. The bud is removed from the scion of equal thickness either by a single incision from bottom to top or by cutting the bark as a patch around the bud with a knife and lifting off the bark. The bud is pushed down into the T-cut on the root-stock and tied with banana fibre, etc. Nowadays polythene tape is commonly used for this purpose. There are divergent views on the lopping of the stock immediately after budding. Normally the bud sprouts in about four weeks. At this stage, the root-stock is cut off about six inches above the bud-union. When the bud has grown about six inches, the root-stock is cut back further to about two inches from the union. All other shoots from the stock are rubbed off.

The commonest root-stock for both mandarins and sweet oranges all over India is the rough lemon, soh-myndong, jambheri, jamburi or jatti khatti (*C. jambhiri*). Karna khatta (*C. karna*) is the root-stock used commonly in U.P. in heavy and wet soils. Nurserymen sometimes use citron, mokri or turanj (*C. medica*) as a root-stock, since it gives saleable plants at an early age, but it is otherwise a worthless root-stock.

More research has been done in India on the study of the influence of root-stocks on citrus than any other aspect of citrus cultivation. In the Punjab karna khatta (*C. karna*) has been found to be the most satisfactory root-stock for grapefruit and rough lemon and nasnaran (introduced from Ceylon) best for sweet oranges. Nasnaran also gave best vigour to and yield in mandarin. Karna shows delayed incompatibility with Blood orange. In Andhra Pradesh, gajanimma (*C. pennivesiculata*) has given good vigour and precosity in sweet oranges, but plants on it decline due to disease, etc. In Andhra the best results were obtained on a sweet orange root-stock with regard to yield and vigour of plants. However, in the wet sub-tropical areas of U.P. karna has been reported to do better than rough lemon in yield and quality.

For mandarins also, rough lemon is the commonest root-stock, but another root-stock which is promising is rangpur (lime). It is especially important in view of the fact that it gives resistance to the tristeza virus disease.

For sour lime, the root-stock gajanimma, which is a poor root-stock for sweet orange, gives very good vigour and yield for the first eleven years in Andhra Pradesh. The sour lime root-stock gives the best yield and produces highly juicy fruits with a thin rind in lemons in South India.

PLANTING AND CARE OF ORCHARD

The budded plants are transplanted in the field after about a year, when their height is about two feet. They are dug out with a ball of earth and the top of the plant is pruned so that it does not dry out due to excessive loss of water from the leaves. In most cool places, the plants are dug out with bare roots or with a small ball of earth. The land for planting is ploughed and levelled and all weeds are removed. In hilly areas, planting is done on terraced land. The plants should be set in the soil so that their bud-union is well above the ground.

Citrus trees are planted in previously-dug and filled pits measuring 3′×3′×3′ in spring or after the monsoon rains in August-September in North India and from July to January in South India. The important thing is to avoid rainy, hot, or very cold months. The pits are refilled with the top soil mixed with about 50 lb. of farmyard manure. In Peninsular India five lb. of wood ash and two lb. of bonemeal are also added. There is a wide range in the planting distance. In the past the planting was done too close. Seedling mandarins on the hill-slopes in Assam and Coorg are planted about 15 feet apart. The tendency now is to plant the trees farther apart and inter-crop when the trees are young. The usual planting distance in the plains is 20 to 25 feet. This distance seems to be large for the hot windy plains. It would be better to do closer planting, which is the tendency in Japan and America now. A distance of 18 feet should be adequate. Sour limes are planted about 15 feet apart. In South India some authorities advocate the wider spacing of 28 feet for seedling trees of Sathgudi orange. After planting, which is done in the evening, the trees are watered.

In the hilly areas the old plantations occur in a semi-condition and no cultivation is done. However, the importance of proper soil management has been realised now and planting after terracing and light tillage thrice a year is recommended. In the plains clean cultivation is commonly practised. It is, however, doubtful if this is the best system of soil management, especially during the summer months, before the rainy season, when the temperature is high and the humidity low. Under these conditions, cover-crops would be much better if irrigation is available. With the wider-spacing of the new orchards, inter-cropping and cover-cropping have become imperative. In some places, coffee is grown as an inter-crop. Vegetables are often grown as intercrops. In the past growing of the leguminous crop of berseem (Egyptian clover) was recommended, since it adds nitrogen to the soil. It is being abandoned now, since it requires frequent irrigation in winter, which is harmful to the citrus trees. In the Punjab, growing of cotton as an inter-crop in young citrus orchards is recommended. Growing of sunnhemp and cowpeas as cover-crops during the rainy season is recommended to control weeds and reduce loss of nutrients from the soil by percolation. *Erythrina lithosperma* and *Crotolaria striata* are grown in South India for this purpose. Green-manuring with sunnhemp, pigeon peas and beans of various kinds is also followed. Recently artificial mulches have been found useful. Asphalt-impregnated paper mulch, dry leaf mulch and black alkathene mulch have been found useful in conserving moisture, regulating soil temperature and checking weed growth. Cultivation of the citrus, especially to keep it free from weeds, is important. Unlike the apple, which can grow well under sod cultivation, citrus cannot stand the growth of weeds. However, in hilly areas like Assam the old plantations have never received any cultivation. In the plains the fields are cultivated three or four times a year. Generally the cultivation is too deep. The feeding roots of the citrus plants are within six inches of the surface of the soil. So the cultivation should be superficial. If there are no weeds, the absence of cultivation would be better than deep cultivation. In fact, in several countries, non-tillage combined with chemical weed control is becoming popular.

Irrigation of citrus, especially in summer, is important. The young plants are irrigated by the basin or ring system and the adult plantations generally by flooding. However, flooding requires too much water and furrow irrigation may be better. No irrigation is required during the rainy months. The critical period for irrigation is summer. Frequent light irrigation during this period is more useful, since it lowers soil temperature and raises humidity. In some places up to 20 annual irrigations are recommended. In the hilly areas, there are no facilities for the irrigation of mandarins. Here the yearly rainfall is generally around 100″, but in summer the trees suffer from serious shortage of water. Frequent irrigation in winter lowers soil temperature, hampers the functioning of roots and is, therefore, harmful. The irrigation water should not directly touch the trunk in summer. Otherwise there is danger of infection of diseases. In the plains, the soil is often heaped around the trunk of the trees to prevent the irrigation water from coming in contact with the trunk. As a result of this, the soil comes in contact with the scion above the bud-union, which is often low. Thus the attack of soil-borne diseases like gummosis is started.

Citrus requires heavy manuring and in India it does not receive the quantity of fertilizers it needs. Of the major nutrients, nitrogen is definitely required to be replenished, even though some old plantations were never manured. The general feeling is that farmyard manure is better than chemical nitrogenous fertilizers. This may be due to the presence of other nutrients besides nitrogen in it. The need for phosphorus and potassium application in some soils has been reported, but it it not felt by most workers. The dose of nitrogen recommended in the Punjab is 1.3 lb. of nitrogen per tree. When applied, half in the form of ammonium sulphate and half as farmyard manure, the yield of sweet orange is increased by 60 per cent. Farmyard manure is applied in winter and ammonium sulphate half before flowering and half a month after fruit-set. Application of 1.3 lb. of nitrogen in the form of ammonium sulphate alone gives only slightly inferior results.

In Central India, the application of farmyard manure ranging from 20 to 240 lb. according to the age of the tree in the beginning of the monsoon is recommended. This quantity can be halved, with the addition of ammonium sulphate starting from 1/4 lb. and raising it to 3 lb. In the Poona area, the recommendation is to add 5 lb. of bonemeal, 100 lb. of farmyard manure and 10 lb. of wood ashes to the pit and 20 lb. of farmard manure, 1 lb. of bonemeal, 3 lb. of wood ashes, and 2 lb. of oilcake after one year. These quantities are gradually increased in five years to five times the initial level. In Andhra, up to three pounds of nitrogen in the form of 200 lb. of farmyard manure, 8 lb. of groundnut cake and 8 lb. of ammonium sulphate per tree are recommended. Most of these recommendations are based upon personal observations and experience of the workers rather than on experimental data.

Symptoms of micro-element deficiency, especially of zinc, are widespread in India. Other micronutrients found deficient are iron, copper, magnesium in Assam and Andhra, manganese in the Punjab, Madras and Coorg and boron in Assam and Andhra. There has been a response to the repeated application of sprays of zinc over a wide area and copper in Coorg and Indore. Zinc, iron and copper are sprayed as sulphates (2-4 lb. in 100 gallons of water with a suitable quantity of lime/acre). Since the deficiency symptoms are often mixed and hard to diagnose, a spray containing 0.5 per cent zinc sulphate, 0.3 per cent copper sulphate, 0.2 per cent manganese sulphate, 0.2 per cent magnesium sulphate, 0.1 per cent boron, 0.2 per cent ferrous sulphate and 0.9 per cent lime has been recommended.

Citrus fruits often get granulated in India. The juice sacs in a part of such fruits become dried up. It is more serious in mandarins. The fruit exposed to the sun is damaged more. Vigorous root-stocks like rough lemon, which we use commonly, give more granulation. Some varieties like Hamlin sweet orange are also more susceptible. No remedy is known but by early harvesting the damage can be minimised to some extent. Fruit-cracking is a problem in lemonimes and lemons and sometimes in sweet oranges, but not in mandarins and grape-fruits. It is caused by severe fluctuations in atmospheric humidity.

Another serious problem in India is the pre-harvest fruit-drop, especially in sweet orange. Whatever may the cause of this drop, it can be decreased considerably by spraying 2,4-D, 20 ppm or 2, 4, 5-T, 10-15 ppm in mandarins and 2, 4-D, 5-20 ppm, NAA 10 ppm or 2, 4, 5-T, 15-30 ppm in sweet oranges.

None of the major fruit crops of India requires much pruning. Citrus, being evergreen like mango, falls in the same category. However, building up of the framework of the tree in the initial stages is important. The tall straight seedling mandarin trees growing like forest trees in Assam certainly leave much to be desired. They have only a small bearing surface at the very top. At the time of planting, the top of the budling is cut off. This encourages several branches to grow from the scion. After six months to one year from the date of planting, three or four well-spaced branches spread on all four sides are retained and the others cut at the base. These branches form the main limbs of the tree. The first branch should arise about three feet above the soil on the adult tree. If the trunk is longer, it is exposed to damage by sunburn. In the bearing tree all water sprouts (thick, angular, upright and thorny branches growing rapidly), diseased shoots, and shoots on which loranthus parasite is growing should be cut off every year. It is, however, unfortunate that generally even this small amount of pruning is not done. In Assam diseased trees with half their main limbs already dead are a common sight. The pruning wounds should be covered with Bordeaux paste, which contains copper-sulphate and lime. The trunks of the trees exposed to the sun should be covered with whitewash to protect them from sunburn.

HARVESTING AND MARKETING

The fruit ripens in about nine months after flowering. The harvesting season varies in different parts of the country. In North India, the fruits ripen in winter, but there is more demand for these juicy fruits in the warmer months. Consequently, huge quantities of sour lime come every summer from Andhra Pradesh to North India. In the South, the crop matures at different times and takes fewer months to mature. Limes and lemons flower several times a year and their fruits mature in about six months. In some places, kagzi lime fruits are available almost throughout the year. However, the main harvesting season is March-April in the Circars, April-June in the Guntur and Nellore area, June-August in North Arcot, and July-September in Rayalaseema and Western India. Sweet limes ripen early and there is a tendency to harvest them even earlier. The Valencia orange ripens late, but its harvesting is done early to vacate the orchard. In both cases, the result is poor fruit quality. This is mostly due to the fact that the standing crop is sold to the contractors, who are anxious to take advantage of the early market and to quit the orchard as soon as possible. The packing of the fruit is poorly done, mostly in long bamboo baskets in the case of mandarins, which are more delicate, and in large gunny bags in the case of sweet oranges. In the past, the fruit has also been directly loaded into railway wagons. Sikkim is the only place where the mandarin fruits are packed in wooden boxes. Grading of the fruit is not done, except to some extent in Coorg. In Andhra Pradesh, grading of sweet oranges was started during the second World War but it died out. The Indian Standards Institute is now preparing standards for the marketing of oranges, etc.

The fruit is generally harvested when it begins to change its colour. However, colour is not a good criterion for harvesting. In high rainfall areas and in areas with a warm winter, the skin colour in citrus does not develop properly. The Sathgudi orange in the South rarely develops the yellow colour when it is harvested. The Musambi in the Poona area develops only a pale yellow colour, but it is harvested even earlier in green condition to catch the early market. Another reason for harvesting early in South India is to escape the attack of the fruit-sucking moth. This results in poor quality of fruit. The oranges and mandarins should have at least 8 per cent sugars at the time of harvesting. The acidity in most Indian varieties varies from .3 per cent to .8 per cent. Mandarins should be harvested as soon as ripe, but sweet oranges can be left on the tree for one or two months after they are ripe. However, if granulation of the fruit is a problem, it should be harvested early. Limes and lemons are harvested when mature but still green, so that their acidity is at the highest level. The fruit is generally not clipped from the tree carefully. To avoid damage to other fruits, the stem of the fruits should be clipped close to the skin with a clipper.

Budded sweet orange trees give a commercial crop in about five years. Mandarins may take one or two years more. Seedling trees take about eight years to come to bearing. The life of budded trees is about 35 years and of seedlings about 60 years. The yield from one acre of sweet oranges is estimated at 8,200 lb. giving an average net profit of about Rs. 600 per acre. The yield of mandarin trees is more variable, since some of the old orchards are neglected. It varies from 4,100 to 30,000 lb. per acre. The yield of sour limes varies from 6,400 to 24,600 lb. per acre. A good sweet orange tree bears about 500 fruits and mandarin about 1,000 to 1,500 fruits.

Sweet oranges may be kept at room temperature in North India for about a month after harvesting. However, mandarins begin to shrink and deteriorate after a week. Their storage in warmer seasons is more important. Dipping the fruits into wax emulsions increases their life, but cold storage is more effective and is now common in India. Ripe mandarins can be stored at 40°F for about three months and sweet oranges for four months at 36°-39 F°. Musambi prefers the higher temperature of 52°F.

CITRUS DECLINE

Even though the area under citrus has been expanding, it has been under grave threat of extinction by citrus decline. The existence of decline in citrus has been mentioned since the 18th century. However, its gravity has been realised only during the last 20 years. Die back is found in all parts of the country, including Assam, Coorg, Nagpur, the Punjab and Ahmednagar. It is a depressing sight to see rows of dead trees from the train in the Nagpur area. However, it is heartening to see new plantations coming up healthily alongside the old dying ones. The trouble does not seem to manifest itself in the young stage of the orchard. Only in rare cases do the trees die outright. Generally, they remain on the border line for a long time. In other places, old trees seem to have come to a stand-still. Actually, it seems to be due to a group of causes. These are poor sub-soil drainage; water stress during critical periods, nutritional deficiencies, lack of orchard care, attack of fungal diseases on the aerial and underground parts of the plant, animal parasites and virus infections.

In earlier days, the emphasis was on defects in texture of the soil and poor drainage. Such conditions are common in the Poona area and parts of the Punjab. In some parts of the Punjab and U.P., where the general water-table is not high, the temporary saturation of heavy soils with free water during prolonged rains seems to be the problem. In places like Coorg, where irrigation facilities do not exist, the severe shortage of water on the hill-slopes in the pre-monsoon period seems to be a strong contributing factor. Similar causes seem to operate in Rayalaseema, a part of Andhra. The importance of malnutrition and low zinc and phosphorus status of the soil has been emphasised by some experts. All over the country there is hardly a place where the citrus trees do not show symptoms of zinc deficiency. Deficiency of iron, manganese, boron, copper, magnesium and calcium is also found in different parts of the country.

The presence of *Phytophthora*, *Diplodia*, *Colletotrichum* and other fungi-causing diseases is common in India. Cracked bark, root-rot and gummosis are evident everywhere. In the absence of a rigid fungicidal programme, especially in the dense plantations of Assam, etc., the trees suffer greatly. Among pests, the shoot and trunk borers, found in Assam and Coorg, etc., are responsible for a great part of the damage. Nematodes have also been reported in Coorg, Wynad and Delhi.

The most important cause has, however, been considered to be the virus diseases. Tristeza virus has been found in India. It has two forms. One causes sudden death of the trees and the other devitalises them. The latter type has been commonly reported from India. Recently, the greening virus disease has also been identified. The only control for the viruses is the use of resistant root-stocks. The root-stock commonly used in India, the rough lemon, has been found to be resistant to tristeza all over the world. This virus, therefore, cannot play a major role in the decline of citrus in India. Citrus is a delicate plant which has not been able to survive in the wild jungles anywhere in competition with other plants. It cannot withstand water stagnation, which prevents the functioning of its roots. It also requires heavy fertilisation. How can such a plant thrive under conditions of neglect? The citrus plantations of Assam and Wynad are virtually thick jungles full of bushes, weeds, lichens and loranthus and are never cultivated or manured. In the plains, the citrus trees get scorched for two months in May and June. Before they recover from this, they are drowned in the deluge of the monsoons in poorly-drained soils. All kinds of pests and diseases thrive in this weather. And then comes the winter of North India with its frosts. The citrus trees face these three types of adverse weather and carry the crop for nine months in the year. To cap it all, there is hardly any place where the required amount of fertiliser (2 lb. nitrogen per tree) is added. Even in Government-owned orchards, the cultivation of land is too deep and it destroys the feeding roots of the trees. In some places, the water-table comes to within two feet of the surface. The cultivator tills the land to a depth of nine inches. That leaves only a 15-inch layer of soil for the root-zone. No wonder that citrus trees are showing a decline. Whatever may be the role of diseases and pests, the major causes of citrus decline are improper management and poor soil drainage.

Diseases and Pests

The most serious disease of sour lime in North India is the citrus canker caused by the bacterium *Xanthomonas citri*. It is not serious in South India. It also spreads to sweet orange plants in the nurseries, but mandarins escape it. It spreads in wet conditions. Spraying with Bordeaux mixture and removal of the affected leaves are recommended, but are hardly effective in serious cases. Streptocycline (3 g in 30 gallons/acre) and neem cake suspension (1 lb. in 2 gallons of water) are much more effective.

Another very serious disease found all over the country is withertip or anthracnose. It is caused by several species of fungi, the commonest of which is *Colletotrichum gloeosporioides*. Spraying with Bordeaux mixture in spring and again in September is recommended. Heavy manuring and painting of pruning wounds with Bordeax paste or zinc-copper-lime should be practised.

Gummosis is very common and is found all over the country. The brown rot gummosis is caused by the fungi *Phytophthora citrophthora*, *P. parasitica* and *P. palmivora*. They also cause dry rot of roots. The rough lemon root-stock is partially susceptible to it and mandarin and sour orange are considered immune but it is said to be the cause of the brown rot of mandarins in Coorg. High budding is recommended as a precaution. Mild gummosis due to *Diplodia natalensis* is also found. Powdery mildew and sooty mould have also been reported. The dry root rot is caused by several fungi (*Fusarium* spp. *Diplodia* spp. and *Macrophomina phaseoli*) and can be controlled by drenching the soil with Bordeaux mixture or other copper fungicides.

Among pests, the most serious are the borers. Fortunately,

they are not important all over the country. *Indarbela tetraonis* and *I. quadrinotata* thrive in areas of high rainfall. The remedy is plugging the tunnels with petrol or carbon bisulphide, etc., or painting them with Paris green. The trunk-borer *Monohammus versteegi* is also found and is controlled by painting the trunks with water dispersible DDT or BHC (1 lb. in 10 gallons). Lime tree borer, *Chelidonium cinctum*, is found in South India. Fruit-sucking moths, *Othreis fullonica* and several other species and genera attack the fruits at night.

The lemon butterflies *Papilio demoleus*, *P. helenus*, *P. polymnestor*, etc., damage the nursery plants. Spray of 0.1% endrin or one ounce of lead arsenate mixed in 4 gallons of water is recommended. *Tarucus theophrastus* and *Psorosticha zizyphi* are also troublesome in the nursery. These are controlled with .25 per cent BHC wash.

The orange leaf-miner, *Phyllocnistis citrella*, mealy bugs, *Pseudococcus citri*, white flies, and citrus psylla, *Diphorina citri*, all of which can be controlled with 0.1% parathion spray, are the other pests. The presence of various scales has also been reported from some places.

CHAPTER V

GUAVA

Guava (*Psidium guajava*) is the fourth most important fruit of India in area and production. It occupies an area of 145 thousand acres. About half of this area is confined to U.P. and about 20,000 acres are found in Bihar. Except for these two States, it is a minor fruit crop. Even though guava occupies a larger area, grapes and apple are gaining greater importance on account of their greater money-making potential. Guava has become so naturalised in U.P. that it is hard to believe that it is not native to India but was introduced from tropical America. It, however, came to India at a very early time before the 17th century. It is a very rich and cheap source of vitamin C and contains a fair amount of calcium. It makes an excellent jelly and does not lose the vitamin C in the preserved forms. The vitamin C content of fresh ripe fruit varies from 100 to 260 mg per 100 gm of pulp. The corresponding figure for oranges is 30 to 70 mg. Its cultivation is gaining importance in Hawaii and Florida in the U.S.A., where more sour types make excellent jellies and a drink called guava nectar.

Botanically, guava belongs to the large family, Myrtaceae. This family includes the eucalyptus tree, several tropical species like cloves, nutmeg, allspice, cinnamon and also the Jaman, Jambolan or Java plum (*Syzygium cuminii*). The Jaman is rarely grown under cultivation except as a border tree. A wild Jaman (*S. fruticosum*) called jamoa is grown as an avenue tree or as a windbreak in U.P. A similar fruit, the gulab-jaman or rose apple (*S. jambos*), grows up to elevations of 4,000 feet in South India and rarely at the foot of the Himalayas.

Apart from cultivated guava, some other allied species with edible fruits are also found in India. But they are not commercially important. The strawberry guava or cattley guava (*P. cattleianum*) has purplish red fruits about one inch in diameter. The tree is smaller than that of ordinary guava, is more cold-hardy and has

shiny leaves. It has a yellow fruited form (var. *lucidum*), which grows in South India from the plains up to an elevation of 5,000 feet. The Guinea guava or Brazilian guava (*P. guinense*) has small fruit of poor quality and rounded branches. The young branchlets in the ordinary guava are four-sided. The feijoa or pineapple guava (*Feijoa sellowiana*) is grown on the hills of South India. It is also reported to be growing in Bengal.

Guava grows in a wide area in India, but guavas grown in Allahabad are famous all over for the fine quality of the fruit. It is a sub-tropical and tropical fruit, which requires a distinct winter for developing good fruit quality which is influenced greatly by the climate. It can withstand drought, but only a few degrees of frost. It does not thrive if the annual rainfall is more than 100 inches.

The importance of guava is due to the fact that it is a hardy fruit which can be grown in poor alkaline or poorly-drained soils without any manuring or irrigation. It can grow in soils with the pH ranging from 4.5 to 7.5.

There is a great variety in the types of fruit. Apple guavas have a brilliant red blush. Some types are pear-shaped and some even look like a bitter gourd or *Karela*. Many varieties have red or pink flesh with distinct flavour, but these usually have an inferior fruit quality. A few varieties are seedless, but their yield is poor and they are not economically important. The most famous variety is the Allahabad Safeda with a round smooth fruit and white flesh of excellent quality. The Chittidar is similar to the Safeda except that it has many pinkish red dots of the size of a pinhead on the surface of the fruit. Lucknow 49 is a seedling selection of Safeda, with a larger tree and larger fruit with rough surface. It bears well and is popular in the Poona area and the Araku Valley in Andhra Pradesh with an elevation of 3000 feet, and in other places in South India. Where the winter is warm it does not do well. The Hafsi is a red-fleshed type. In Bihar, apart from Safeda, the other varieties grown are Harijha and Habshi with dark green fruit. Some of the other varieties are Dholka, Nasik and Dharwar.

Guava is commonly propagated from seed, which germinates in about three weeks. Boiling the seeds for five minutes, soaking them in water for two weeks prior to sowing or treating them with strong sulphuric acid for five minutes facilitates their germination. Some weird practices are also followed to get fruits of good quality. In Gujarat, some people wash the seed repeatedly to make the flesh of the fruit whiter and in Satara the seeds are sometimes treated with a sugar syrup to make the resulting fruits sweet. These are fallacies. In any case, the raising of guava plants from seed is not desirable, since the seedling trees differ greatly from the mother-plants. Inarching, which is the common method of propagation in mango, is a successful method of propagating guava. Veneer-grafting, T-budding, Forkert-budding, layering and air-layering or gootee are also practised. Layering is common in South India. Cuttings can be rooted especially after treating them with chemicals like NAA. However, as in the case of mango, seedlings can withstand frost better than grafted plants.

The trees are usually planted about 15 to 20 feet apart in U.P. In some places, the trees are planted more thickly, but this is not desirable. The seedling trees under good care can be planted a little farther apart. In South India, in good soils the planting distance is 20 to 25 feet.

Guava is rarely pruned in North India, but light annual pruning after harvesting to promote vegetative growth and flowering is desirable. In Madras, the bearing shoots generally die after the fruit is harvested. Under these conditions, removal of dead shoots and pruning-back of the other shoots are recommended. Pruned trees give larger fruits and early ripening.

Guava bears fruit more than once a year. The flowering in spring gives a crop in the rainy season and the flowering in the early monsoon season gives a crop in winter. In South India, flowering also takes place in October and gives a third crop under irrigation. Guava will bear almost throughout the year here. It is desirable to take only one crop in a year. In South India, the rainy season crop is preferred even though it is of poor quality, since the price is high at this time. In U.P. the winter crop is of a better quality and the fruit also escapes the attack of white flies. Removal of the

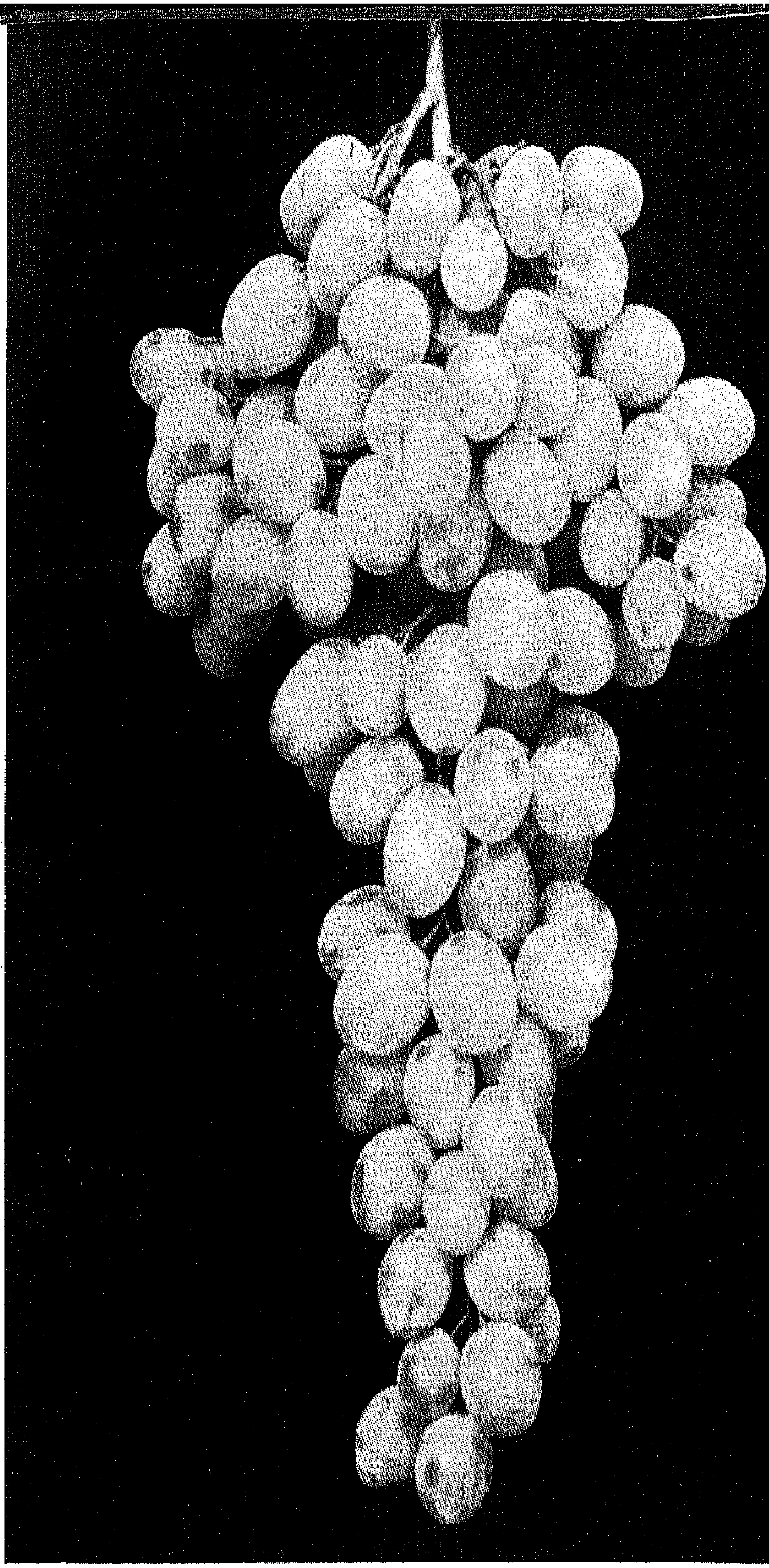


Plate 5. PUSA SEEDLESS GRAPES (*Vitis vinifera*)
(*page 101*)

Plate 6. SPRAYING OF GRAPES (*Vitis vinifera*) TRAINED ON A BOWER OR 'PANDAL' (*page 107*)

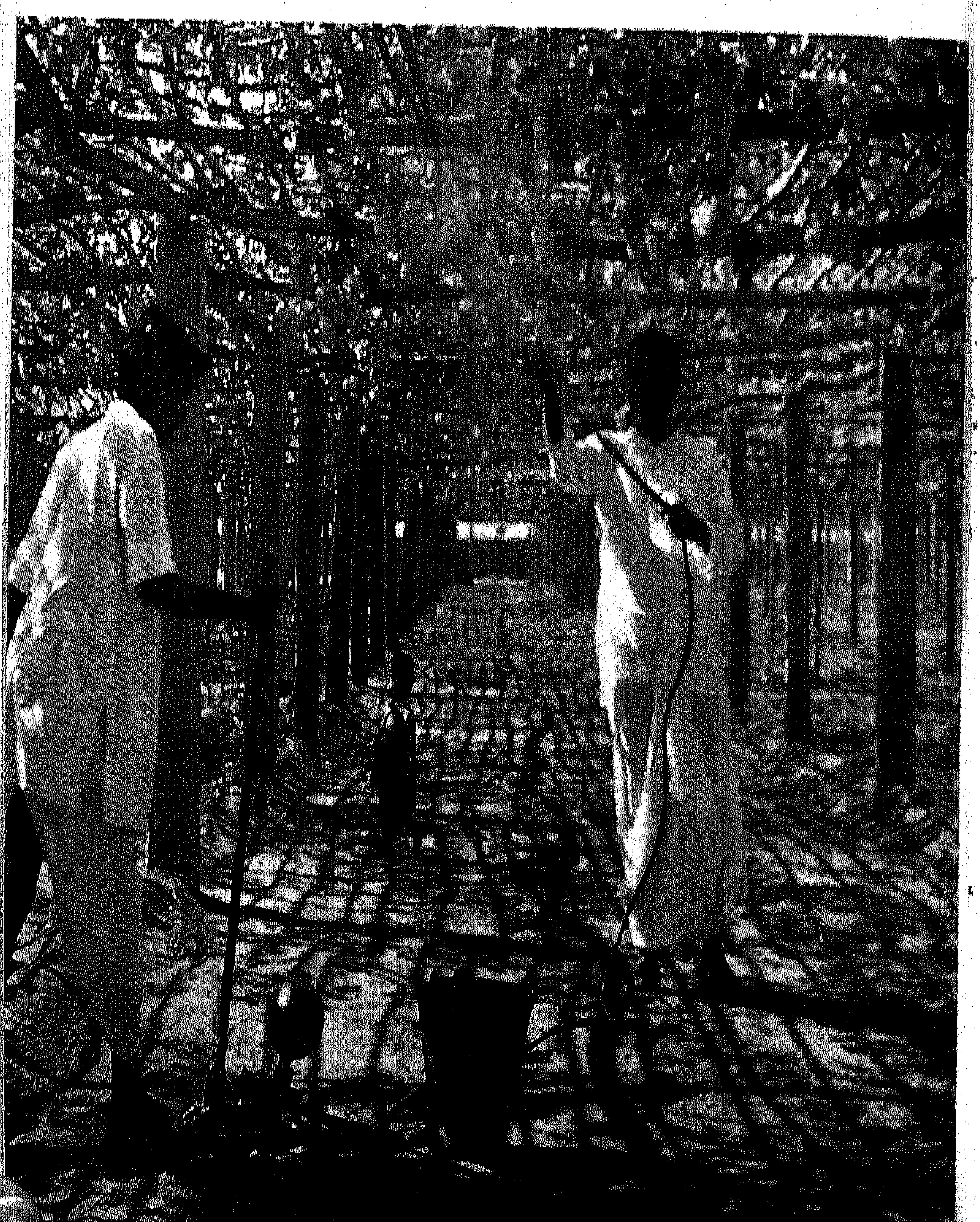


Plate 7. ATEMOYA (*Annona* sp.) (*page 112*)

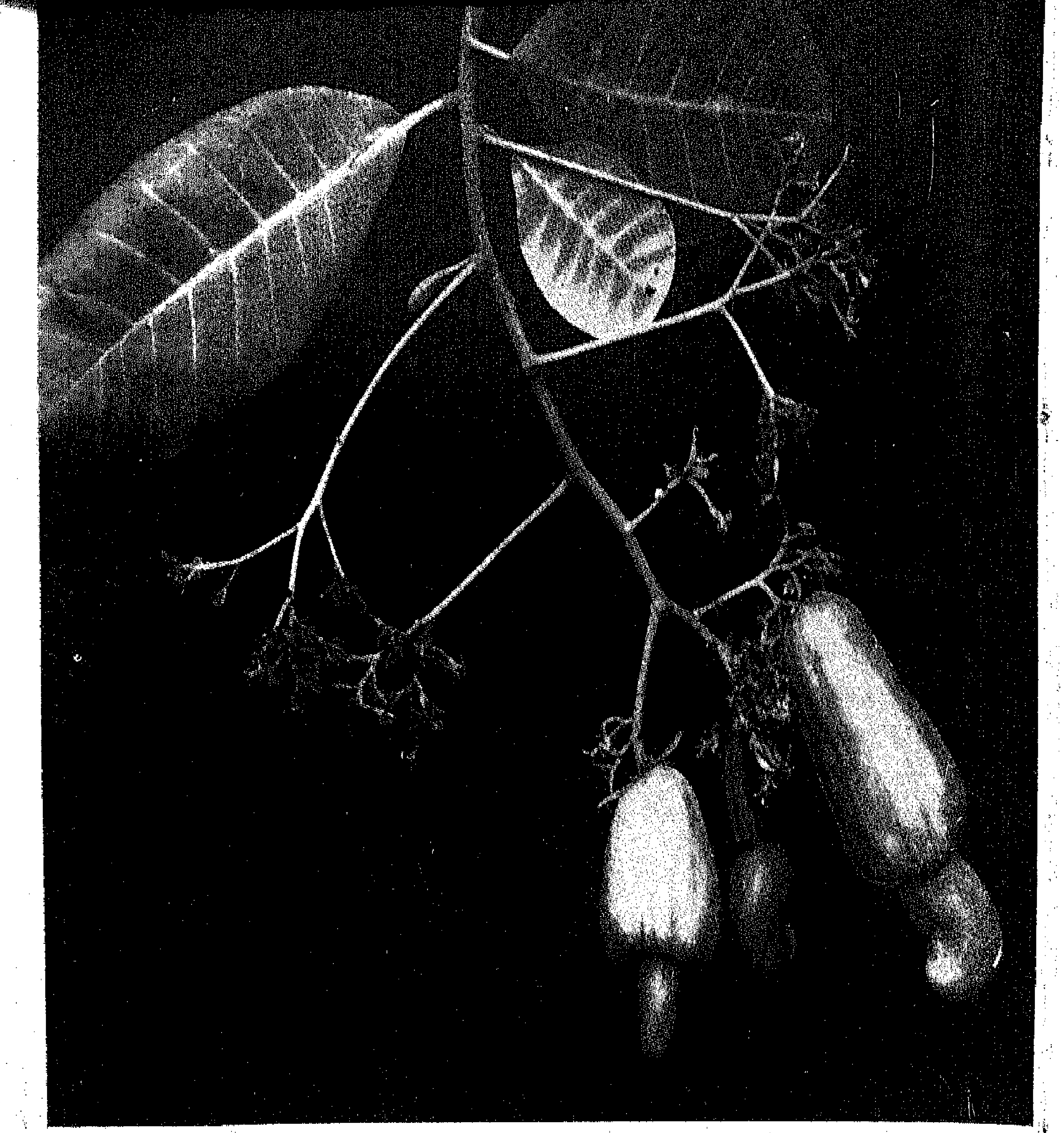


Plate 8. A Nut of Cashew along with the Cashew Apple (*Anacardium occidentale*) (*page 113*)

fruits of the rainy season crop by hand would be too expensive. This is accomplished by not giving any irrigation to the trees from December-January to the start of the monsoon. The fruits set in spring are shed soon afterwards in the heat of summer due to water stress. Under these circumstances, the only time the plants would be irrigated is in autumn after the monsoons when the trees are bearing crop. In actual practice, however, irrigation is rarely done. In Western India, root-pruning of guava to regulate the season of harvesting, as is done in the case of mandarins, is recommended in heavy soils only. In lighter soils, simply withholding of water serves the purpose. In Poona, bending of branches and tying together branches of adjoining trees is recommended to improve fruiting.

Guava does not receive any manure in practice, but it does require some manuring. The manurial dose of 200 lb. of leaf-mould, 7 lb. of groundnut cake and 7 lb. of ammonium sulphate per tree recommended in Andhra Pradesh seems excessive. But guava never suffers from excessive manuring and consequent vegetative growth since it bears fruit on fresh growth. Guava sometimes suffers from deficiency of zinc. This has been reported from Ajmer. The area between the veins on the leaves develops yellow patches, the leaves become small and the growth and bearing of the trees are reduced. It is serious in water-logged areas. Spraying the trees with 1 lb. zinc sulphate and .7 lb. of slaked lime dissolved in 16 gallons of water cures this condition. Two such sprays for an acre are effective.

Guava fruits ripen five months after flowering and they are harvested when their colour changes to yellowish green. Bearing commences when the trees are three years old. The average yield per acre for India is only 2.2 tons, but a yield of 10 to 15 tons per acre is obtained in Allahabad in U.P., 10 tons in Bombay and 4.5 tons in Bengal.

Guava fruits are highly perishable and the birds play havoc with them even when they are not ripe. So it does not pay to plant only a few guava trees, since the cost of bird-scaring over a long period is prohibitive.

Guava does not suffer from any serious disease or pest. Fruit flies (*Chaetodacus* sp.) damage the fruit in the rainy season. The insects lay their eggs under the skin of the fruit. The maggots make the fruit unfit for sale. The affected fruits should be destroyed, the soil ploughed up several times and the rainy season crop avoided. Other pests—mealy bug, bark-eating caterpillar and guava scale—are not serious.

A serious disease, the guava wilt, is sometimes encountered, especially in alkaline soils. It is caused by the *Fusarium* fungus. The species of the fungus found in U.P. is *F. oxysporum* and in Bengal *F. solani* and also *Rhizoctonia bataticola. F. psidii* and *Macrophomina* phaseoli are also found. On the affected trees, whole limbs first dry up. The tree eventually dies and there is no remedy except avoiding water-logged and alkaline soils.

The anthracnose disease caused by the fungus *Collectotrichum psidii* is found in the submontane areas of U.P. and can be controlled by spraying 3:3:50 Bordeaux mixture.

CHAPTER VI

PAPAYA

THE MELON TREE, papaya or papita (*Carica papaya*) belonging to the family Caricaceae seems to have been introduced into China as an Indian plant, even though this tropical plant is a native of Mexico. It came to India *via* Malacca in the 16th century. It has gained the greatest popularity in Hawaii. In India there was a prejudice against this fruit in the beginning. In the Punjab the fruit was considered to have a disagreeable odour and in South India it was considered to cause some women's ailments. Now it has become popular all over India and is commercially the fifth most important fruit of the country. It has gained most popularity during the last 50 years.

The reasons for its rapid popularity are simple and strong. It comes to fruiting in about a year, gives the highest production of fruit per acre and an income next to the banana. Under ideal conditions, apples and grapes give more income, but not higher yields. The yield can go up to well over 100 tons per hectare. It is a nutritive fruit containing .5 per cent protein and an equivalent amount of minerals, consisting mainly of iron, calcium and phosphorus 2,500 international units (mango has 5,000 units) of vitamin A, 70 mg of vitamin C (ascorbic acid) per 100 gm of fruit and is rich in the enzyme papain, which helps in the digestion of proteins. A small piece of raw papaya cooked along with meat makes it very tender. The papain content of the fruit decreases rapidly as it ripens. So ripe papaya is not effective as a meat-tenderiser. Papain is a very useful product. It is said to remove skin blemishes, is considered beneficial for the treatment of stomach ulcers, diphtheria and even cancer. It also has industrial uses. It is used in the clarification of beer, in the tanning industry and in the manufacture of chewing-gum. Raw papaya is cooked as a vegetable or made into pickles. The ripe fruit and the seeds are also considered to have medicinal properties against disorders of liver, spleen and the digestive tract. Papain extracted from the unripe fruit can fetch Rs. 35,000 per hectare. After the extraction of papain the scarred fruits are harvested and can fetch another Rs. 15,000 per hectare.

Papaya has some characteristic features. Most of the fruits are slow-growing, woody perennial trees and are vegetatively propagated. Unlike these, papaya is a herbaceous plant, the stem of which is usually not branched, which is raised from seed and gives fruit in about a year. It has a crown of palmately veined large leaves with very long leaf stalks. The date palm has male and female trees, but the papaya has male, female, hermaphrodite (with male and female flowers on the same tree) and some other complex forms. The sex of the flowers on the same tree can undergo change with season, age and injury. The male flowers hang in long trusses. The female flowers and perfect flowers are borne in small clusters in the axils of leaves. Sometimes in summer, a few small fruits are found hanging on the ends of long stalks of the clusters of male flowers. On the other hand, in Hawaii the change of sex towards femaleness is seen in the cool weather. Fruits from the perfect flowers are more elongated, angular and less attractive than those from the purely female plants. A few male trees have to be retained in the plantation for pollination of the female flowers. In the absence of this, a few seedless fruits may develop, but these are commercially worthless. Seedlings from mixed seed give rise to plants of various sexes. It would be desirable to identify the sex of the plants in the nursery bed so that unwanted male trees may be discarded. Many efforts and claims have been made to identify the sex of the seedlings on the basis of the appearance of the seeds, vigour of the plants and some chemical tests. It has also been claimed that the sex of the male plants can be changed by manuring or decapitating them. None of these methods has been found practicable and some of them are baseless. However, the decapitation of the plant, if only one new shoot is retained on it, gives fruits of good quality in Florida.

If the female trees are pollinated with hermaphrodite ones the progeny consists of only female and hermaphrodite plants. In this case, male plants, which do not bear any fruit, are not required for pollination of females. However, the hermaphrodite plants are not as productive as the female ones. So the best plan is to plant a large number of seedlings and uproot the male plants after flowering. This gives highest yield and income.

Papaya is a tropical plant, but it also does very well in a mild tropical climate. It is very sensitive to frost. Another type of papaya, called the mountain papaya *C. candamarcensis*, can grow up to an elevation of 2,000 metres, but it produces numerous fruits of poor quality. Papaya does not like strong, hot or dry winds. Dry climate at the time of ripening is preferable. Under high humidity, the fruit quality is said to be inferior. In high rainfall areas and poor drainage of soil, the cultivation of papaya is impossible due to the death of the plants caused by the collar-rot disease. However, a hardy species, *C. monoica*, grows in the upper Amazon basin with an annual rainfall of 375 cm. There is no frost or a hot dry period in this area. This species produces male and female flowers on the same plant. The fruit of this species is worthless and is of no commercial value.

Papaya is grown all over India. Even in Rajasthan, where both frost and hot winds are found, it is grown in sheltered places. In Jaipur city, papaya is seen growing in small fields enclosed in three metre-high stone walls. It is difficult to estimate the area under papaya since the plantations are retained only for about three years and are being constantly replaced. The total area under papaya in India is estimated at about 10,000 ha. Of this the major part, about 4,000 ha., is in Bihar. Assam has slightly less than this area. U.P., Andhra, Gujarat, Madras and Mysore are other States where papaya is important. It grows in various types of soil in India. The most important consideration is that the soil should be well drained. Light soils are very good for papaya, if they are adequately manured. Sticky and calcareous soils, where rain water may accumulate even for a few hours, are not good.

Papaya is normally propagated from seed all over the world.

The seeds should be rubbed with wood ash and dried before storage. The time of sowing the seeds is important and depends upon the choice of fruiting season and danger of rain or frost. In North India, seeds are sown from February to April. The seedlings are transplanted after about two months, when they have four to five leaves. June is a good month for transplanting. If irrigation during summer is plentiful, earlier planting is desirable. As a result of this, the plants are larger when winter comes and are able to withstand frost better.

In Central India, papaya flowers throughout the year and fruit can be had at any time during the year except the monsoon months, July to October. So the planting time is more flexible. In this area, the seeds are sown in the rainy season. Transplanting in December gives fruits on plants when they are much shorter.

The seeds are sown one and a half cm deep on raised beds. The distance between rows is 15 cm. The distance from seed to seed in the rows should also be the same, otherwise the seedlings will have to be transplanted very soon. The seeds germinate in three to four weeks. The seed-beds are protected from rain and strong sun with a cover of thatch. About 600 gm. of seed is enough to give plants for one hectare. Vegetative propagation by grafting or cutting is possible. The cuttings root well after treatment with three to five per cent IBA (Indole butyric acid). However, they give weak plants. Probably seed propagation imparts vigour to the plants, which have a tendency to become senescent after a few years.

Papaya is often planted as a filler tree between newly-planted mango and orange groves. It is planted two to three metres apart. Closer planting gives protection against frost and hot winds and checks the growth of weeds. However, this practice requires more manuring and irrigation. Large planting pits are not required for papaya. Papaya will grow even without previously-dug pits. The pit is useful while adding manure to it. The size of the pit is generally ½ metre × ½ metre. The top soil from the pit is mixed with about 20 kg. of farmyard manure and filled back into the pit. The larger leaves of the seedling are cut off at the time of transplanting. The seedlings are normally transplanted with a ball of earth, but in South India they can be transplanted even with bare roots on a cloudy day in the rainy season. The seedlings should not be planted too deep in the soil. If a part of the stem is buried in the soil, it is more likely to be affected by collar-rot later on. At the site of each pit three seedlings are planted about 15 cm. apart. The plants flower in about 10 months in North India and in five in the South. At this stage all male plants are uprooted, leaving about a five per cent male population in the field.

Papaya is a shallow-rooted plant, which should never be given deep tillage. Only the removal of weeds at the young stage is important. The cultivation should be frequent and light. However, it requires heavy manuring and irrigation, since the growth is so quick and the crop produced is so heavy. Irrigation should be given every 10 days in winter and every week in summer, provided there is no rain. When there is danger of frost, irrigation is useful. Irrigation should be done by the ring method, which is followed in Gujarat and prevents the water from coming in contact with the stem.

About 25 to 35 kg. of farmyard manure should be applied to each plant before flowering commences. The same dose should be repeated every year. Application of about 400 gm. of ammonium sulphate will supply the same amount of nitrogen and is equally effective. Application of bonemeal and wood ashes has also been advised. Application of superphosphate and potash improves the yield and quality of fruit.

If necessary, trenches are made between the rows of plants during the monsoon so that rain water does not stagnate in the field. Thinning of fruits, when they are about 3 cm. long, gives large fruits of a regular shape. The operation should be performed frequently. The extent of thinning should be such that the fruits do not touch one another when mature. Too much thinning reduces yield.

In North India, harvesting starts from December, about 16 to 18 months after planting, and lasts four to five months. In Central and South India, the crop starts from February. It takes about six months to flower and another five for harvesting. The fruits ripened on the tree have the best quality but for sending them to distant markets, they are harvested when they are firm, and when only the apical end has started turning yellow and the latex is no longer milky. They can be ripened well by treatment with one part of ethylene gas in 5,000 parts of air, but this is not practised in India. The yield per tree in India varies from 20 to 150 fruits per annum. The average weight of a fruit should be at least one kg.

Since papaya is propagated from seed, which is not produced under controlled conditions, the identity of the different varieties is not clear. Probably the only well-established papaya variety in the world is the Solo, since this is the only variety cultivated in the Hawaii Islands. It now produces plants with only female and perfect flowers. The variety Honeydew or Madhu Bindu in India is said to come fairly true to type from seed and has a small proportion of male plants. It bears fruits low on the trunk, the yield is heavy and has elongated fruits with comparatively few seeds. A selection from this, the Coorg Honeydew, produces only female and hermaphrodite plants and no pure males.

The variety Washington also comes fairly true to type from seed. It has yellow flowers, dark purple petioles of leaves, purple rings on the stem, and dwarf plants. Co-1 is a selection made in Madras State from the variety Ranchi from Bihar. It gives uniform plants. The Gujarat variety bears heavily, but its fruit is not of good quality. The variety Barwani from Indore is of good quality and bears well in North India. However, it shows wide variation and has fruits with deep orange as well as yellowish flesh. Some of the other varieties are Hawaii, Singapore and Ceylon. Some nurserymen have been making greatly exaggerated claims for their varieties and exploiting the desire of the growers to get a standardised variety. Their plants have not borne out their claims.

Papaya has no serious insect pests, but it has some serious diseases. The most serious disease is the collar-rot or foot-rot, caused by a soil-borne fungus (*Pythium aphanidermatum*). During the rainy season it causes swelling, cracking and rotting of the stem, where it comes in contact with water. It is hard to prevent or cure, but can be checked by three sprayings of 6-6-50 Bordeaux mixture during the rainy season and drenching the soil around the stem with the same mixture or Vepam. Root-rot in papaya may be caused by the same fungus or by *Rhizoctonia solani* and *Fusarium* sp. No specific control measure is available.

These fungi can also kill young seedlings in the nursery. This can be prevented by sterilisation of the nursery-bed with formaldehyde two weeks before sowing or treating the seeds with Captan, Ceresan or Agrosan G.N. Anthracnose, leaf-spot, fruit-rot and powdery mildew are also found.

Virus diseases are serious in papaya. Leaf-curl is common in North India, especially where drainage of the soil is poor. The leaves of the plants become crinkled and the plants remain stunted. The virus mosaic is also common. It starts as necrotic dots on the leaves. The lamina becomes yellowish green, malformed, upright and with blistered patches on it. Fruiting is also affected. The virus-affected plants should be quickly destroyed to prevent the spread of these diseases, since no cure is known.

The insect pests of papaya are not serious. The most important is the red spider-mite. It can be controlled by spraying lime sulphur. The caterpillar, *Dasyses rugosellus*, and root knot nematodes have also been found. Birds are the most serious pests of papaya. Bird-scaring is an important item of expenditure in the cultivation of this crop.

CHAPTER VII

GRAPES

GRAPEVINE IS the most important sub-tropical fruit in the world, occupying about 26 million acres. However, 80 per cent of the crop is used for wine-making alone, 10 per cent for raisin-making and only 10 per cent is used as fresh fruit. In India, it occupies only a small area, but it is one of the most paying fruits. Consequently, the area under grapes in India has been increasing rapidly during the last five years. Most of the grapes in India used to come from Afghanistan, but after the creation of Pakistan, many difficulties arose in their import. A small quantity of grapes used to be cultivated around Nasik, near Bombay. These grapes were of inferior quality and could sell only because they came to the market in spring, whereas the crop from Afghanistan ripens in August-September. The area under grapes in India began to increase rapidly due to the high price commanded by the fruit. Even though the seedless grapes, for which the demand is so great, do not develop the optimum quality and berry-size in India, the yield is very high under tropical conditions.

The grapevine is a subtropical plant, which sheds its leaves during winter and requires dry heat during its ripening period. The plant continues to grow all through the year in Hyderabad and in South India. This results in an exceptionally high yield, but poor fruit quality. Consequently, the requirement of fertilisers is very high. The average yield per acre in India is over four tons, which is higher than the yield in California and far exceeds the yield in other important grape-growing countries like France, Italy and Spain. In the Madurai district in Madras, the variety Pachadrakshai has given a record yield of 28 tons per acre. The same variety gives a yield of 15 tons per acre in the Nasik area regularly. The variety Anab-e-Shahi gives a yield of 14 tons per acre in Hyderabad. This results in a high profit, the fruit selling at about one rupee per pound.

The seedless varieties give lower yields but they sell at a much higher price. The initial expense of establishing a vineyard is exorbitant due to the cost of trellis wires or overhead bower for their training. Only a few growers can afford to invest the necessary capital, which may go up to Rs. 15,000 per acre. However, the vineyard starts bearing in the third year and the profits are so high that the entire investment can be recovered in one or two crops. In Madras, the vineyard sometimes gives a crop in the second year.

The area under grapes in India has been expanding rapidly. It rose from 1,500 acres in the pre-Partition days to 7,000 acres in 1962. Now the area has substantially increased further. The principal centres of grape cultivation are Madurai in Madras State, Nasik and Poona in Maharashtra, Hyderabad and Aurangabad in Andhra Pradesh, the Punjab and Haryana. The last two States have concentrated on grape-growing during the last two or three years and their crop has just begun to come into the market. In North India the grape is grown in sub-tropical climate, where the grapevine sheds its leaves in winter and the vegetative growth takes place for only a part of the year. Here the yield is low, but the cost of cultivation is much less. Diseases like powdery and downy mildew are rarely found here, the vines require little plant protection measures and the cost of cultivation is thus much less. Grape cultivation has also been started in an area of Himachal Pradesh called Chini. It borders on Tibet and is a dry area in the interior of the Himalayas. The annual rainfall is a little over 10 inches. This area is being developed for growing raisin grapes. India imports substantial quantities of raisins annually. The quality of the grapes grown in India is not good enough for making raisins, which require a high percentage of sugars. The raisin grapes generally have 24 to 28 per cent sugars, which include no sucrose. The sugar content of grapes grown in India varies from 13 to 22 per cent. The sugars do not develop fully in the humid weather of South and Central India or the scorching weather found at the time of ripening in North India. Attempts have been made to make raisins from grapes grown in Delhi by artificially treating them with sugar, but the product is leathery, sticky and of an indifferent quality. The vineyards in the Chini area are just beginning to bear and it remains to be seen how successful it would be in supplying raisins. On account of a cool summer, this area may have difficulty in making raisins by sun-drying.

Grape originated in the Caspian Sea area and came to India at a very early time. Commercial table grapes belong to the species *Vitis vinifera* all over the world, including India. About 125 other species of *Vitis* are reported to be found growing wild in India. Out of these, *V. barbata*, found in Burma, Assam and Bengal, *V. rumcisperma* found in Assam and Sikkim, *V. rugosa* found in Burma and Kumaon Hills and *V. parviflora* found in Kashmir give edible fruits though of poor quality. Another related fruit, *Ampelocissus latifolia*, is found growing wild in Bihar around Bhagalpur. It has tuberous roots. The plant dies in winter and sprouts again from the tubers when the monsoon starts. The berries are of poor quality and ripen from August to October. The plant is highly resistant to pests and diseases.

It is evident from the fact that grapes grow in widely different areas from the interior of the Himalayas to the tropical areas of Madurai, that it can be grown in a wide range of climatic conditions. However, the same variety does not do well under all climatic conditions. For example, Anab-e-shahi forms the basis of a booming industry in Hyderabad, where growth takes place all through the year, but it does poorly in North India, where there is a prolonged rest period during winter. The weather during the fruiting season affects the quality of fruit. Dry weather at the time of flowering is necessary for a good fruit-set. Rain or humid weather at the time of ripening causes splitting of berries and brings on an attack of fungal diseases. In North India, the problem is to get varieties which will ripen before the start of the monsoon. Here the maximum temperature at this time goes up to 115°F. Consequently, the berries get sun-scalded and develop a thick skin. In Western India, there are two crops. One ripens in September-October after the monsoon rains, is of poorer quality and is often attacked by mildew. The other ripens in March and is sometimes damaged by occasional frost.

Light soils are ideal for grapes, but they can grow in any well-drained soil. In fact, grapes can be seen growing even in poorly-drained soils, but their performance would certainly improve in a better soil. They can tolerate saline soils successfully. Only the date-palm can tolerate more salts in the soil than grapes. In Madurai, grapes are grown on very poor, gravelly soils.

VARIETIES

In India the demand is for seedless varieties with a high sugar content like the Thompson Seedless and Haitha. Unfortunately, such varieties are not very suitable for most parts of India. The varieties which give heavy yields in India are seeded.

The most widely cultivated variety is Bhokri or Pachadrakshai. It gives the highest yield, but the fruit quality is mediocre and the keeping quality is poor. The berry is large, rounded and yellowish-green. It does not perform so well in North India. Selection 7 is a seedling of Bhokri which does better than the parent variety in Poona and has a better keeping quality. Another seedling of Bhokri, No 94, has oblong berries of better quality and is prolific in bearing.

Fakhri was at one time the second most important variety of Western India. It is most vigorous, but the yield is poor and so is the keeping quality. The bunches are large, loose and the berries are oval, green, seeded and very sweet.

Pandhari Sahibi is shy-bearing and slow-growing. The berries are whitish, long, as large as those of Bhokri and with a good keeping quality and an excellent fruit quality. It requires pollination by other varieties.

Anab-e-Shahi is the mainstay of grape cultivation in Hyderabad and is also gaining importance in Maharashtra. The berries are very large, greenish-yellow, firm, of an excellent keeping quality, seeded but with a mediocre fruit quality. It gives a very high yield in these areas on the pergola system, but does not do so well in North India.

Pusa Seedless is a seedless variety resembling Thompson Seedless, Sultanina or Oval Kishmish. The berries are small, slightly oval, greenish-yellow and of a very good quality. It is early and very successful in Northern India. The Speen Kishmish grown successfully in Madurai is similar, but has a rounded berry.

Perlette is a new variety from California introduced recently. It is seedless, greenish-yellow and oval. It is slightly earlier than Pusa Seedless, but has a tough pulp, which is not of an equally good quality. The ripening is also uneven. However, it is the most promising variety for North India.

Some of the other important varieties are Beauty Seedless, with dark purple, exceedingly sweet, seedless berries of a low keeping quality (good for home gardens in North India) ; Cardinal with large, purplish, seeded berries of an exceedingly high quality; Black Prince, an early variety with dark purple, seeded berries; Bharat Early with very small greenish berries of exceedingly high sweetness; R.L.S., which is similar to Golden Queen, Gros Colman, Kandahari, Hur, Kali Sahibi and Bangalore Blue. The last variety is a hybrid of the American species *V. labrusca* and is very successful around Bangalore. The berries are large, dark purple, seeded and rather sour. It gives a good yield in Bangalore and does not suffer from mildew. In North India, it does not ripen in time.

Grapes are propagated by cuttings in India. In countries where the phyloxera root louse is a problem, they are propagated by grafting on resistant root-stocks. Cuttings are made from one-season-old mature canes after the pruning. The cuttings are 9″ to 18″ long. The lower cut is immediately below a node and is a square cut. The upper cut is slanting. In North India, the cuttings are prepared in February and often planted after keeping them in bundles in moist sand for four to eight weeks for callus formation. They are planted in the nursery and transplanted in the field after one year. In Western India, the cuttings are planted in the nursery in October and transplanted in the field in January. In South India, the cuttings are often planted directly in the field. Sand and *neem*-cake are added to the planting pit to keep off termites and four cuttings are planted in each pit. Finally, only one of these is retained. This method gives earlier fruiting, but the care of the cuttings in the field is expensive and laborious.

In grape cultivation, the most important and expensive operation is the training, pruning and staking of vines. In a tropical climate, pruning is done twice a year. The time of pruning determines the time of fruiting. In Western India, severe pruning is done in March after harvesting to encourage vegetative growth. The crop from the growth after this ripens at the end of the rainy season in October, is of a poor quality and is affected by mildew disease caused by fungi. This crop is not taken. A second pruning is done in October. It is lighter and encourages fruiting. The crop is harvested in March. In Hyderabad this pruning is delayed till the first week of November to escape the attack of the scab disease. In the south, the seasons are a little late. The fruit ripens in March-April and again in October-November, which is considered the second summer season in this area. Here both of these crops are taken. Pruning is done in May-June and December-January after inducing rest in the vines by withholding irrigation for a fortnight. In North India, pruning is done once a year at the end of the winter season and the fruit ripens in May-June. Earlier pruning does not give an early harvest. Thus the grapes from different parts of the country ripen in different seasons and do not compete with one another.

The common methods of training grapes all over the world are the head system and the Kniffin or trellis system. However, in India the two commonest systems are the bower system and the single-stake system.

The pergola, bower, pandal or overhead arbour system of pruning gives a high yield in Hyderabad and South India and is suitable for vigorous varieties. In this system, the vines are planted wide apart—12′ × 15′ or 15′ × 18′. The vines are allowed to branch at a height of six or seven feet. No branch is allowed to grow below this height. A criss-cross network of wires supported by masonry, concrete or iron pillars or live stakes of pangara (*Erythrina indica* or *E. suberosa*) is created. This structure may cost up to Rs. 10,000 per acre. The arms of the vines are trained horizontally on all sides over the arbour. Several spurs of up to five buds are retained on each arm during the annual pruning. The grape bunches hang down and are thus protected from the direct sun. The yield is high in this system of training. It is very good for the Anab-e-Shahi variety.

The common system of pruning in Western India is the single-stake system, which is a modified vertical cordon. The vines are planted eight feet apart in January. All side sprouts are rubbed off till April. When the vines are about five feet tall, the topmost four buds are allowed to develop and about six-foot long cuttings of pangara are planted along each vine. The lower half of the pangara is whitewashed and the upper half painted with coal tar in May. These pangara cuttings strike roots very soon. The new shoots arising from the four shoots retained on the grapevine in April are pruned back to three or four buds in October. Next April, 15 months after planting, all new shoots are pruned back to a single bud. Thereafter the type of pruning given in April and October is repeated every year. Of the four bud spurs retained after the October-pruning, the topmost one usually bears fruit and the bottom one remains dormant. This spur along with its shoots is cut back to one bud in April. The basal bud then sprouts and forms a cane. After about four or five years, the vines become strong and are tied together with bamboo poles. A few canes (branches) from the adjoining vines are brought together and tied along the bamboo poles. Fruiting spurs of four or five buds are retained on these horizontal branches after the October-pruning every year. The vine now becomes a horizontal cordon, has a much larger bearing area and the yield increases threefold. This method is also followed in Hyderabad. Instead of bamboo poles, trellis wires of iron can also be used. This system is good for Bhokri but not for varieties which bear fruit on long canes.

The Kniffin, espalier, or cane-system of pruning is popular in North India. It costs less than the bower system. The vines are trained horizontally along two trellis wires strung on iron supports, one wire being at a height of about three feet and the other at five feet. The trunk of the vine grows vertically. One arm about a foot long is allowed to develop along each wire on either side. Thus each vine has four arms. Long shoots developing into canes are cut back to a length of six to 12 buds, depending upon the variety. Two canes are retained on each arm and are tied along a trellis wire. At the base of each cane, another shoot on the same arm is cut back to about two buds. This is called the renewal spur and the shoots arising from it form the canes in the following year. Cane-pruning is suitable for varieties like Pusa Seedless or Thompson Seedless, in which the shoots arising from the basal buds do not bear fruit. This system is sometimes modified. The arms of the adjoining vines are allowed to grow towards one another along the wires. From these arms the canes hang down instead of being trained along the trellis wires. It gives a larger bearing area and a higher yield.

In the head system, which involves least initial investment, the trunk grows to a height of about four feet and is supported by a wooden stake. Up to ten short arms are developed permanently from the top of the vine. This forms the head. On each arm several spurs of four to six buds are retained annually for fruiting. This method is useful for varieties like Beauty Seedless, in which the basal buds on a cane bear fruit.

In South and Central India during the fruiting season all secondary shoots and tendrils are rubbed off and the bearing shoots pinched, leaving four leaves beyond the last grape-bunch on the shoot. Grapes bear a heavy crop without any pruning, but the berries become small in size and the plants suffer more from diseases. The grape bunches are borne on shoots arising from the buds on one-season-old canes. The purpose of pruning is to reduce the number of bunches and to encourage vegetative growth and to ensure fruiting the following year.

The vineyard should be kept free from weeds and frequent shallow tillage is desirable. Irrigation is important, but it seems to be overdone in some parts of India. In many parts of the world grapes are grown without artificial irrigation. In North India, up to nine irrigations from March to the ripening of fruit in June are given. No irrigation is given during the monsoons or in winter. In Western India, six irrigations are given during the fruiting season from October to March and three from April till the break of the monsoon.

Grapes do not require very heavy manuring. They require only a moderate amount of nitrogen and a fairly high amount of potash. However, in tropical India, very high manuring is done in view of the growth of the plants all through the year and consequent high yields. In Madurai 25 tons of green leaves and 25 tons of farmyard manure per acre are added. In Maharashtra 60 to 100 lb. of farmyard manure is given to each plant after the April pruning. In addition to this, 100 lb. each of bonemeal, potassium sulphate and ammonium sulphate per acre are also recommended. This dose is apparently high. No manuring is done after the October pruning. In Hyderabad the recommended manurial schedule per vine is: farmyard manure 100 to 200 lb., castor-cake 5 to 12 lb., and bonemeal 8 lb. after the April pruning and the same amount of farmyard manure and castor-cake plus fish meal 6 lb., ammonium sulphate 1 lb., potassium sulphate 1 lb. and superphosphate 3 lb. after the November pruning. In North India, where grape-growing is of recent origin, the application of 50 lb. of farmyard manure in winter, 1 lb. of ammonium sulphate in March and again in April is recommended.

Grape is a tender watery berry and needs to be harvested and handled very carefully. However, if handled properly, it reaches from Afghanistan to India by the land route in a good condition. The fruit is regularly shipped from Madurai in South India to Calcutta. It is often shipped in bamboo baskets lined with soft grass or in earthen pots in the Bombay area. Now small wooden boxes containing 8 lb. of fruit are coming into vogue. These are lined with paper cuttings or wood wool, etc. Grapes must be harvested when fully ripe and when the coloured varieties have developed their colour. Unlike mango and banana, they do not ripen after harvesting. Co-operative marketing societies for the sale of grapes are coming up in places like Madras.

DISEASES AND PESTS

Grapes suffer from many serious diseases and pests especially in tropical conditions, where annually three sprays of Bordeaux mixture (1%) and four dustings with sulphur (10-20 lb./acre) are necessary.

The most serious disease is the powdery mildew caused by the fungus *Uncinula necator*. It develops in a hot sultry weather, but not during actual rain. It is serious in Madras State and in Maharashtra, where it is active in October. White powdery patches appear on both surfaces of leaves, on shoots and flowers. It hinders fruit-set, the young berries fall off and the vines may show wilting. Ripe berries are not affected. It can be controlled by dusting finely-powdered sulphur starting two weeks after pruning up to the time the berries are half-grown. Auriofungin sprays (2.5 gm in 50 gallons) are effective in controlling fungal diseases of grapes.

Downy mildew, caused by the fungus *Plasmopara viticola*, develops in wet weather. It is serious in Madras State. A greenish yellow spot appears on the upper surface of the leaf. This spot turns brown and dries up. A whitish down may appear below these spots on the lower surface of the leaves. It also attacks the bunches. Three sprays of 5:5:50 Bordeaux mixture can control it. All vines should be pruned at the same time and the prunings destroyed if the disease is present.

Anthracnose, caused by the fungus *Elsinoe viticola*, develops in wet weather at lower temperatures and is serious in Maharashtra and the South. In the North it is often the cause of the death of plants in the nursery or after transplanting. It causes canker on leaves and shoots and red spots with grey centres on the berries. It is controlled by spraying 5:5:50 Bordeaux mixture in May and in the end of July in South India. Here late pruning in November helps to escape the attack of anthracnose as well as downy mildew. All diseased shoots should be removed and pruning wounds painted with 5 lb. ferrous sulphate and 280 cc. of concentrated sulphuric acid dissolved in one gallon of water. Other diseases found in India are brown leaf spot caused by *Cercospora viticola* which is often found during the rainy season in North India, root-rot caused by *Dematophora necatri*, black rot caused by *Guignardia bidwelli* and rust caused by *Phakospora vitis*.

The variety Bangalore blue is comparatively disease-free, but it suffers from a blight caused by the fungus *Coniothyrum diplodiella*. Its control is the same as that for anthracnose.

The most important insect pest of grapes is the flee beetle, *Scelodonta strigicollis*, found in Maharashtra and the South. It eats the buds and hibernates in the bark or among dried leaves in winter. It can be controlled by adding 1 lb. of Paris green to 100 gallons of Bordeaux mixture sprayed to control diseases, etc. Lead arsenate can also be used or a mixture of DDT and BHC sprayed after pruning. Other insect pests found in India are the leaf-roller, cockchafer beetle, grapevine sphinx, leaf-miner, the vine-girdling beetle and a scale. These, however, are not very serious.

CHAPTER VIII

OTHER TROPICAL FRUITS

CUSTARD APPLE

In the genus *Annona* of the family Annonaceae, five fruits are considered edible. Four of these are called the custard apple in different countries. In India only the sweet sop or sugar apple, *Anona squamosa*, is called the custard apple. It is the most important among these fruits in India, and is called sitaphal or sharifa in the vernacular. Another species common in India is bullock's heart, *A. reticulata*, locally called Ramphal. The sour sop, *A. muricata*, is also found in some places. The pond apple or alligator pear, *A. glabra* (*A. palustris*), is found among the plant collections of some gardens. These fruits grow semi-wild in large numbers in forests in the Hyderabad area (about 40,000 hectares), in Madras State, Assam and to some extent in U.P. It may be hard to believe, but in spite of its widespread adaptation in India since a very long time, the custard apple is an introduced fruit in India. All of these fruits have made themselves at home in India and the different members have been named after Ram, Sita, Hanuman and Lakshman. In spite of this intimate connection with the story of the *Ramayana*, all members of the genus *Annona* undoubtedly originated in tropical America. There seems to be some doubt about the time of their arrival in India. When the Portuguese came to India, they brought these fruits with them. However, it is likely that at least *A. squamosa* (sitaphal) was already present in India. This fruit was mentioned in the *Ain-e-Akbari*, the biography of Emperor Akbar, written only about 100 years after the discovery of America. It is seen in the old paintings at Ajanta, in the sculptures at Mathura and the Bharut sculptures. It seems that this fruit spread from tropical America from both its coasts long before the discovery of America and had possibly reached India before the Portuguese landed here. It will be hard to convince many people in India that custard apple and guava are not indigenous to this country, but that is the truth.

These tropical fruits prefer a dry climate, can withstand mild frost, but their fruits become hard and do not ripen in cold weather. They are evergreen, but when grown in North India, they often shed their leaves in the cold weather. They do not like hot dry winds at the time of flowering in late spring, and consequently they do not set fruit in spring in North India, but readily do so when the rainy season starts. Their roots are shallow and they do not require a deep soil. However, the soil should be well drained. They thrive on light soils, but can also grow in heavy soils. They can stand high amounts of lime found in calcareous soils. They are often found growing on rocky soils. The soil is, therefore, not very important for these fruits.

SITAPHAL OR SHARIFA

Unfortunately, the name sitaphal is also used for the red pumpkin in India. Almost all trees of custard apple found in India are seedlings. Their production, fruit-size and quality are far from uniform. Some types like Mammoth and red custard apple are said to come more or less true to type from seed. However, the weight of the fruit often varies from 150 gm. to 300 gm. within a type. Some people believe that these differences are due to the environmental influence of the soil, etc., and that vegetative propagation of better types would not be useful. However, vegetative propagation is very easy and the custard apple can be most successfully inarched on bullock's heart (*A. reticulata*) and the trees perform very well. Budding in the month of June or January-March on the same root-stock is also very successful. The seeds can remain viable for seven years, but it is preferable to use fresh seeds for raising root-stocks. The hard seedcoat can be softened by soaking it into water for four days.

Spacing the trees about four metres apart is adequate. In India no manuring, irrigation or pruning is done. However, in regular plantations these operations will improve the yield and quality of crop.

The custard apple starts bearing at the age of two to four years and declines after about 12 to 15 years. The yield is poor and the fruits have a gritty texture and many prominent bony seeds. The average yield in India is 100 to 150 fruits per tree. The trees flower over a long period and harvesting extends from September to November. Fruits, which are not ripe in November, fail to do so later in the cold weather. Most of the trees grow wild and the only cost involved is that of harvesting, so the neglected condition of the trees and the low yield are tolerated in this crop. The fruits do not ripen well on the trees and are artificially ripened under straw. Harvesting is done in several instalments. It is a very perishable fruit. The properly ripened fruit has up to 16.5 per cent sugar and is a great favourite with small children.

The varieties of custard apple are not well established since it is propagated from seed. However, some broad types are well established. A red or crimson type has smaller leaves and fruits. The fruit and the major veins of leaves are purplish red and the flesh is deep pink. The fruit is of an inferior quality. Its seedlings come true to type. Mammoth has fruits with more flesh and less seed. The reticulations on the surface of the fruit are large and the tree is small. Its plants come true to type when raised from seed. Balanagar also has superior fruit. Fortunately, the custard apple is free from diseases and pests in India.

A similar fruit, ilama (*A. diversifolia*) is popular in Mexico, but has not been tried in India. Another anona fruit found all over India is *A. reticulata*, the Ramphal, bullock's heart or bull's heart. The fruit is larger and smoother, and with hexagonal markings on the surface. It has fewer seeds but the pulp is of a poor quality. Two distinct types of fruit with regard to fruit shape are found in the Ramphal. It is less resistant to cold, and does better in somewhat heavier soils. It ripens during March-May. A dry rot of the fruit of Ramphal is found in Assam and is caused by the fungus *Glomerella cingulata*.

Cherimoyer or cherimolia (*A. cherimola*) has been introduced into India comparatively recently. It can stand a little more frost than the custard apple and grows well in Assam and on the hills in South India up to an elevation of 2,000 metres. It cannot stand extremes of humidity and does not do well in the dry summers of North India. Its fruit is considered to be of best quality among the anonas. Its fruit is larger than that of custard apple, less gritty, and has more buttery and sour pulp with a marked pine-like aroma and fewer seeds. However, it is not as sweet as the custard apple. It is slow to come to bearing. Trees budded on bull's heart come to bearing in about six years. The fruits ripen in December-January and the yield is less than 100 fruits per tree. However, it has been shown in California that the yield can be improved by the hand-pollination of flowers. There is some confusion about its local name. The name Lakshmanphal seems to designate this fruit. A natural hybrid of this fruit with sitaphal called atemoya is more common in India and is also found in Egypt and Israel. It is locally called Hanumanphal. Its climatic requirements are similar to those of the custard apple, except that it can stand a little cooler climate. It can tolerate a variety of soils and can grow even in fairly alkaline soils. Its fruit is less gritty and resembles the cherimoya more. The seeds are few and the pulp is smooth, less sweet and more sour as compared to the custard apple.

The largest fruit in this group is found in *A. muricata*, the sour sop or mamphal. The fruit weighs 1½ to 3 kg and is covered with sharp pyramidal spines, somewhat in the manner of a jack-fruit. It is sour in taste and is very popular in Cuba and Burma. It requires a most tropical climate among this group and does not grow in North India. It is found to some extent in Assam and the plains of South India. It does not bear more than 25 fruits per tree.

CASHEW

Cashewnut is one of the most important items of export from India. The latest available figures show an annual export of 49 million kg. worth about 408 million rupees. However, India also imports substantial quantities of the raw nut, which is re-exported after shelling. The shell of the nuts contains, apart from an oil, some poisonous substances which blister the skin in the process of shelling. The nuts are, therefore, roasted before shelling, which is done by human labour in India. Almost all the cashew produced in East Africa used to come to factories on the West coast of India for shelling. This quantity was as much as the indigenous production in India. Now mechanical shelling of the nuts has become feasible and factories have been installed in the East African countires for shelling. This avenue of income for India is, therefore, coming to an end. However, in view of its foreign exchange potential, its production in India is being increased.

The cashew, *Anacardium occidentale*, belongs to the family Anacardiaceae, to which also belongs our most important fruit, the mango. It is one of the most delicious and most nutritious nuts of the world. It contains up to 47 per cent fat, 21 per cent protein and 22 per cent carbohydrates and is also rich in minerals like calcium, phosphorus, iron and vitamins B_1 and riboflavin. It, therefore, fetches very high prices.

The cashew in the shell is a kidney-shaped nut borne on a very much swollen stalk, which is juicy and is called the cashew apple. The cashew apple is sweet but astringent. It is also rich in vitamin C. It makes a very good bottled juice after the removal of the tannins present in it, which cause the astringency. Even the oil extracted from the shells is exported from India. The annual export of this oil is worth about Rs. 0.6 million.

The cashew is a strictly tropical plant, which requires a moist, mild tropical climate. It cannot stand the cold or the dry hot summer of North India. In South India it thrives on the coastal areas and on hills up to 1,000 metres. Its cultivation upto 1,500 metres is possible. It grows in areas with a rainfall ranging from 100 cm. to over 400 cm.

It is generally grown as a wasteland crop. Well-cared-for plantations of cashew do not exist. Accurate statistics are, therefore, wanting. The total area under cashew in India is 194,000 ha. Its cultivation is centred primarily on the west coast of Kerala (83,000 ha.) Other centres of production are Goa, Daman and

Diu (33,000 ha.), the coastal areas of Andhra (17,000 ha.), Madras (43,000 ha.), Mysore (8,000 ha.) and to a small extent Orissa and Bengal. Its cultivation has also been started in Assam.

Ordinarily, the cashew is grown on sandy soils in the coastal areas or on rough hilly lands with no irrigation, manuring or pruning. It is grown with almost no care, but it is not planted in heavy black cotton soils. The propagation is done by seed. In the month of June, two seeds are sown in previously-dug pits of half a metre diameter and half a metre depth, which have been filled up. The pits are three metres apart. The seeds germinate in two to four weeks. The trees are thinned out in the early years and only one seedling per pit is retained. After five years, only about 250 trees per hectare remain; on good soils the number of trees should be halved. Propagation of trees of selected quality and high yield is possible by inarching, layering, side-grafting as well as shield-budding.

There are no established varieties of this crop. The trees may start bearing after two years, but reguler cropping starts after five years. It gives a good yield from the age of 10 years to 25 years. It is harvested in April-May. The yield is low since the trees are neglected. The yield per tree is estimated at 10 kg. on the Kerala coast, 15 kg. on the Andhra coast and 20 kg. in Orissa. Apparently, the yield is low in areas of very heavy rainfall. The cashew is a hardy tree and survives the attack of animals, birds, diseases like die-back and mildew and insect pests like thrips, caterpillars and borers. This matter has not received adequate attention and no plant protection measures are taken. Still the cashew remains an important source of foreign exchange to us.

Shoot and inflorescence drying caused by *Gloeosporium mangiferae* and die-back of shoots caused by *Pellicularia salmonicolor*, are major diseases of cashew in India. Both can be controlled by removal of affected parts and application of crude carbolic acid followed by Bordeaux paste. The algal red-rust disease on leaves, *Cephalurus mycoidia*, is controlled by dusting nickel chloride in early stages.

JACK-FRUIT

The jack-fruit, *Artocarpus heterophyllus* (*A. integrifolia*) is another fruit of great importance in India which is not generally cultivated in regular plantations. It is one of the few fruits which are indigenous to India. It gives the largest fruits, which are borne on small leafless stalks arising from the trunk and main branches of the tree. Sometimes fruits from the underground parts of the tree are seen emerging out of the soil. The large fruits can weigh up to 40 kg. The fruit is extensively used for cooking, but the ripened fruit is also quite tasty. Fruits of some trees have a sweet and firm pulp and of others a soft and more acidic pulp. The male and female flowers of the jack are borne in separate drooping catkins. Male catkins are much more profuse and do not develop into fruits. It belongs to the family, Moraceae, to which belong fig and mulberry.

In India the greatest production of jack-fruit is in Assam, which has an area of about 8,000 ha., Bihar about 4,000 ha, and the trees found in South India would occupy the equivalent of about 1,200 ha. There is also some area in U.P. In North India, this tropical fruit grows along the foot of the Himalayas and in South India up to an altitude of 2,400 metres. It is found wild on the Western Ghats of India and is a common sight around every home in Kerala. It is often used as a shade tree in coffee plantations. In South India, it produces more food per acre than any other fruit. Its total production ranks only after mango and banana in these areas.

It is universally grown from seed. The germination is improved if the seeds are soaked in water for 24 hours. In South India, its inarching on seedlings of Rudrakshi jack-fruit or on *A. hirsuta* is successful. In Java it is successfully budded by the modified Forkert method on root-stocks of *A. chempeden* and *A. rigida*. In India air-layering has been found successful in the North. If the exposed portion of the layer is dipped in Seradix A, .025 per cent solution of betaindolebutyric acid or naphthalene acetic acid, the success can go up to 100 per cent. In North India the plants flower in winter and the fruits ripen in summer, but in Assam and South India the fruit is available almost throughout the year.

Jack-fruit needs a spacing of 10 to 13 metres from tree to tree. It requires plenty of water, but is very sensitive to stagnation of water in the soil. No insect pest or disease of jack-fruit is serious. However, several, borers are found on it mostly in the humid areas. Out of these, the stem-borer, *Margaronia caesalis*, is most serious in Assam, Andhra Pradesh and U.P. It can be controlled by spraying BHC or DDT. The brown weevil, *Ochyromera artocarpi*, also found in Assam, which bores into tender buds and fruits, can be controlled by destroying the fallen fruits and buds. Other insects reported are the borer *Botocera rufomaculata* and the moth *Perina ruda*.

In Assam, the fruits sometimes develop a soft rot while still on the tree. It is caused by the fungus *Rhizopus artocarpi*. It can be controlled by regular spraying of Bordeaux mixture during the fruiting season. Brown leaf spot caused by the fungus *Phomopsis artocarpina* is found in North India, but is not serious.

Apart from the ordinary jack-fruit, there is another type called Rudrakshi. It comes fairly true to type when grown from seed, but its fruit is much smaller and of a rather poor quality. The quality is even poorer at higher elevations. The fruit is also less spiny. It comes to bearing sooner and is used as a root-stock. The Singapore jack or Ceylon jack is a good type, which is precocious. Another species with small fruits of poor quality which are edible is the monkey jack, *A. lakoocha*, found wild in Bengal. *A. hirsuta*, with edible fruits also occurs wild in India. A related fruit which is important in the Polynesian Islands and in Burma is the bread fruit, *A. altilis* (*A. communis*). It requires a more humid and tropical climate. A few trees of it are found on the lower hill slopes of the Nilgiris in South India. It is used only for cooking and a seedless type propagated from root-suckers exists.

PINEAPPLE

The pineapple (*Ananas comosus*) belonging to the family Bromeliaceae is one of the few monocotyledonous fruits like the banana. It is a native of Brazil and had reached India by 1548. In the mind of an ordinary person, the name pineapple is associated with Hawaii and Singapore, but its cultivation in these places developed around the turn of the century. Pineapple and peaches are two fruits which are commercially more important as canned fruits than in their fresh form. Canned pineapple juice is also an exceedingly important product. It is partly due to the fact that pineapple, which contains no starch in the unripe condition, does not develop a good quality if harvested unripe. For distant markets the fresh fruit has to be harvested firm. The quality of the canned product is, therefore, much more uniform than and superior to the fresh fruit generally available in the market.

In India, the area under pineapple is about 1,000 hectares. It is grown mostly in the erstwhile Travancore-Cochin State on the West Coast, in Assam, coastal Andhra Pradesh, Madras and West Bengal. It thrives in a mild tropical climate. Strong sunshine is not desirable. Complete shade is also not suitable, but in India it is sometimes grown in partial shade. In Kerala State, where the rainfall is heavy, it is grown as an intercrop in banana and coconut. A mildly cool winter gives fruits of a better quality.

Pineapple is grown on various types of soils in different parts of the world, including very poor soils. In fact, the quality of the fruit grown on light soils is considered to be superior. In India, sandy and loamy soils and the laterite soils on the hillslopes in South India have been found very suitable. In several parts of the world, where the soil is alkaline or contains an excess of the element manganese, the plants are unable to absorb sufficient iron from the soil. Salts of iron have to be sprayed on the leaves of the plant under these conditions.

Pineapple is very easy to propagate vegetatively. Suckers arising in the axils of leaves on the main stem below the fruit or the underground part of the stem form roots and can be used for propagation.

Even the crown of leaves above the fruit and parts of the stem itself can be used. In South India and Assam, the suckers from the main stem are used since plants from them bear a crop earlier than plants raised from the slips, which are suckers arising immediately below the fruit. The latter, however, give larger fruits. Crowns are often used in the propagation of the variety Smooth Cayenne or Kew, which produces few suckers. The pineapple suckers can be stored for several months before planting and are allowed to get dry before planting. In fact, if fresh suckers are planted in moist soil, they begin to decay. Some of the lower leaves are removed from the suckers before planting. This facilitates the formation and entry of roots into the soil. The pineapple has shallow roots, which also develop at the base of the leaves along the stem. These roots enable the plant to absorb water and nutrients collected at the base of the trough-like leaves. In India, pineapple is normally planted during the rainy season, avoiding periods of heavy downpour. This period is August in Assam and September-November in Bombay. Planting on ridges can also be done to avoid damage from heavy rains. The plants are fixed firmly in the soil since they anchor poorly to the soil due to their shallow roots. However, the soil should not cover the growing point of the plant at the time of planting.

Pineapple is generally planted close so that adjoining plants give support to one another in avoiding being uprooted and ensuring protection from sunshine. The various planting systems followed in India accommodate from 10,000 to 17,000 plants per hectare against double this number found in other countries. The plants are generally set 50 cm. apart in the rows, which are 60 to 90 cm. apart. After every two to four rows, a path 1½ meters wide is left.

Pineapple needs light and frequent irrigation due to its shallow roots. Irrigation is done only during the dry months from January till the break of the monsoon. Weeding is important. In South India, a mulch of leaves or straw is spread on the soil between the plants. In Hawaii, the soil is covered with asphalt-impregnated paper mulch in which holes are made in places where the plants are to be set. This practice is too expensive to be practical in India. A pineapple plantation is retained for 1 to 10 years in different countries. If the soil is very rich, it can go on even for 30 years. In India, it is retained for about three crops. The subsequent ratoon crops are borne by the suckers given out by the original plant, as in the case of banana. Only two of these suckers are retained and all others removed. When only a few ratoon crops are taken, cultivation is of less importance and the plants can be planted closer. Hardly any tillage is given in Singapore.

Pineapple requires heavy manuring, but in Assam manuring is often neglected. It can absorb nitrogen in the form of ammonia. Ammonium sulphate is, therefore, the best fertilizer for it. Application of 20 to 30 tons of cowdung manure per hectare to be applied during the first six months is recommended. In most countries the pineapple ripens in summer and the crop ripening in winter may be sour. In India, the first crop ripens in winter or spring, 15 to 20 months after planting, which is done in the rainy season. Thereafter the fruits ripen mainly in July-August from the flowers appearing in February-March. In the more uniform climate of places like Hawaii, several methods like smudging, placing of calcium carbide in the axils of upper leaves of the plants and sprays of naphthalene acetic acid (NAA) are used to induce flowering at a given time, so that the crop would ripen in a favourable season. The calcium carbide on contact with moisture gives out acetylene gas, which is the same gas as used in the welding process.

The fruit is harvested when it turns greenish-yellow and the leaf-like scales around the eyes on the surface of the fruit dry up at the ends. The yield in India is rather low. The various estimates vary from 8 to 25 tons per hectare. In Hawaii, the present-day yield is about three times this quantity.

The most important variety in India is the Giant Kew or Smooth Cayenne. It has ash-grey leaves with smooth margins, large fruits with an average weight of 3 to 4 kg each. The Giant Kew of Kerala seems to be in a different class from the one found in Assam. This variety is most important for canning. Mauritiuts is the second most important variety. The average size of its fruit is 1½ to 2½ kg.

Queen is another important variety. It has sharply-serrated leaves, and a small fruit of excellent quality as fresh fruit. Its fruits weigh from 1½ to 2½ kg each. It is not good for canning and is preferred in West Bengal. Ripley Queen and Red and Green Ripley are also related to this variety and are found in some parts of India. Simhachalam is another small-fruited variety found in coastal Andhra Pradesh. Jaldhup is a similar variety found in Assam. Lakhat is a wild type found in Assam and has small, acidic fruits with an alcoholic flavour.

Pineapple is comparatively free from insect pests and diseases in India. Among its diseases the basal rot, caused by the fungus *Ceratostomella paradoxa*, is serious in Assam. The fungus can live on the trash in the soil and is easily spread through the planting material, insects and wind. The fungus can cause leaf spot and fruit rot. Smearing the cut ends with 0.5% benzoic acid reduces the incidence of disease. Heart rot of the stem caused by *Phytophthora parasitica*, which attacks citrus trees, can also cause damage in patches. It can be controlled by good soil drainage and dipping the suckers into 1-1-50 Bordeaux mixture before planting. Rotting of the roots is caused by another strain of the same fungus. Its symptoms are similar to those caused by *Phytophthora cinnomoni* in Queensland. Among insect pests, the mealy bugs (*Pseudococcus brevipes* and other species) have been reported from Kerala. Planting material free from the pest should be used. It can be controlled by spraying Parathion or Malathion.

SAPOTA

The sapota (*Achras zapota*), sapodilla, or bully tree, commonly called sapota in India, belongs to the family Sapotaceae. It is a tropical tree native to Tropical America. Like the guava, it is so well established in India that the man in the street considers it to be indigenous to India. Actually, its cultivation in India spread

Plate 9. KEW PINEAPPLE (*Ananas comosus*)
(*page 119*)

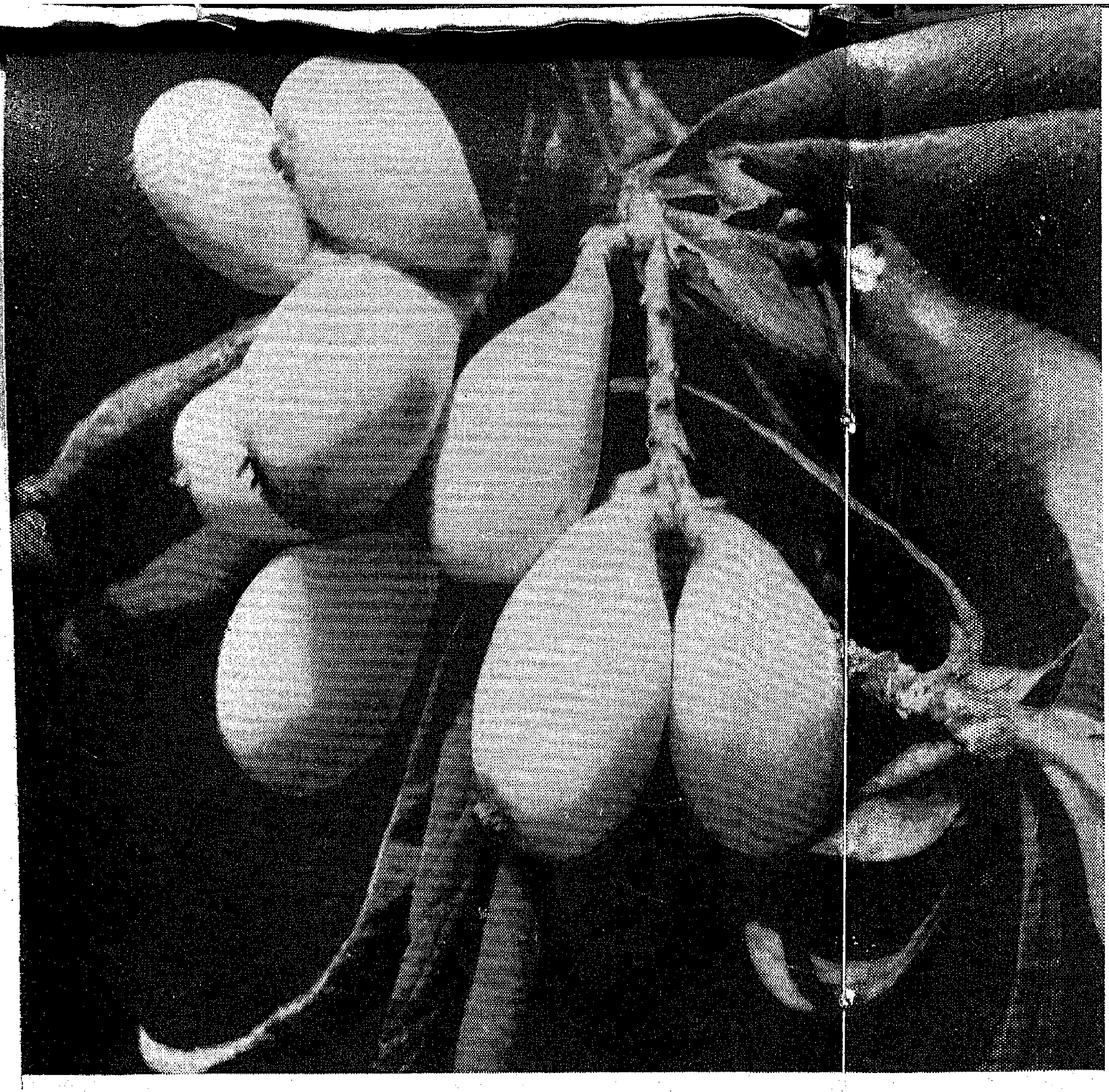
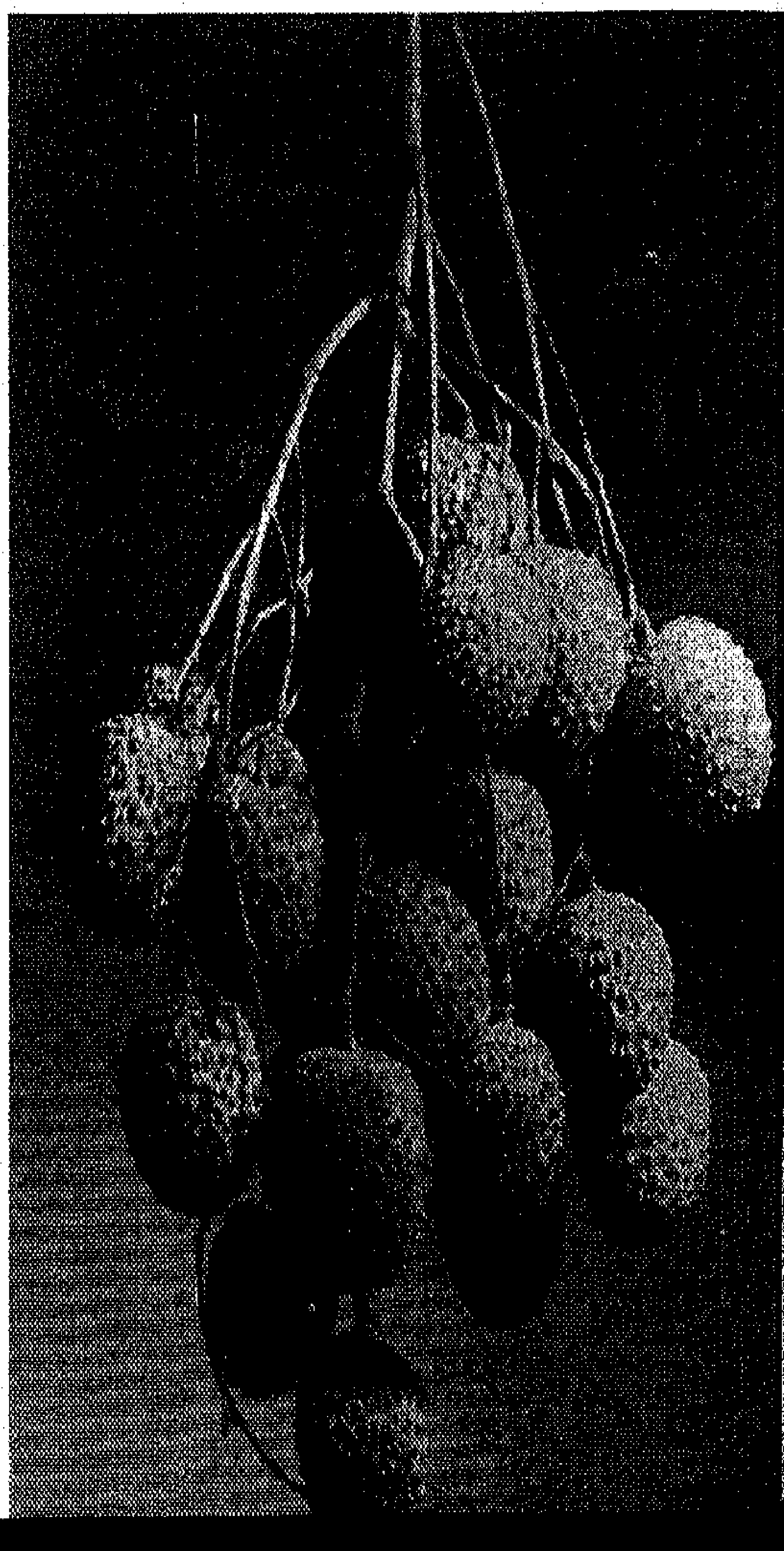


Plate 12.
LOQUAT
(*Eriobotrya japonica*)
(*page 137*)

Plate 10.
A BUNCH OF LITCHI
(*Litchi chinensis*)
(*page 127*)



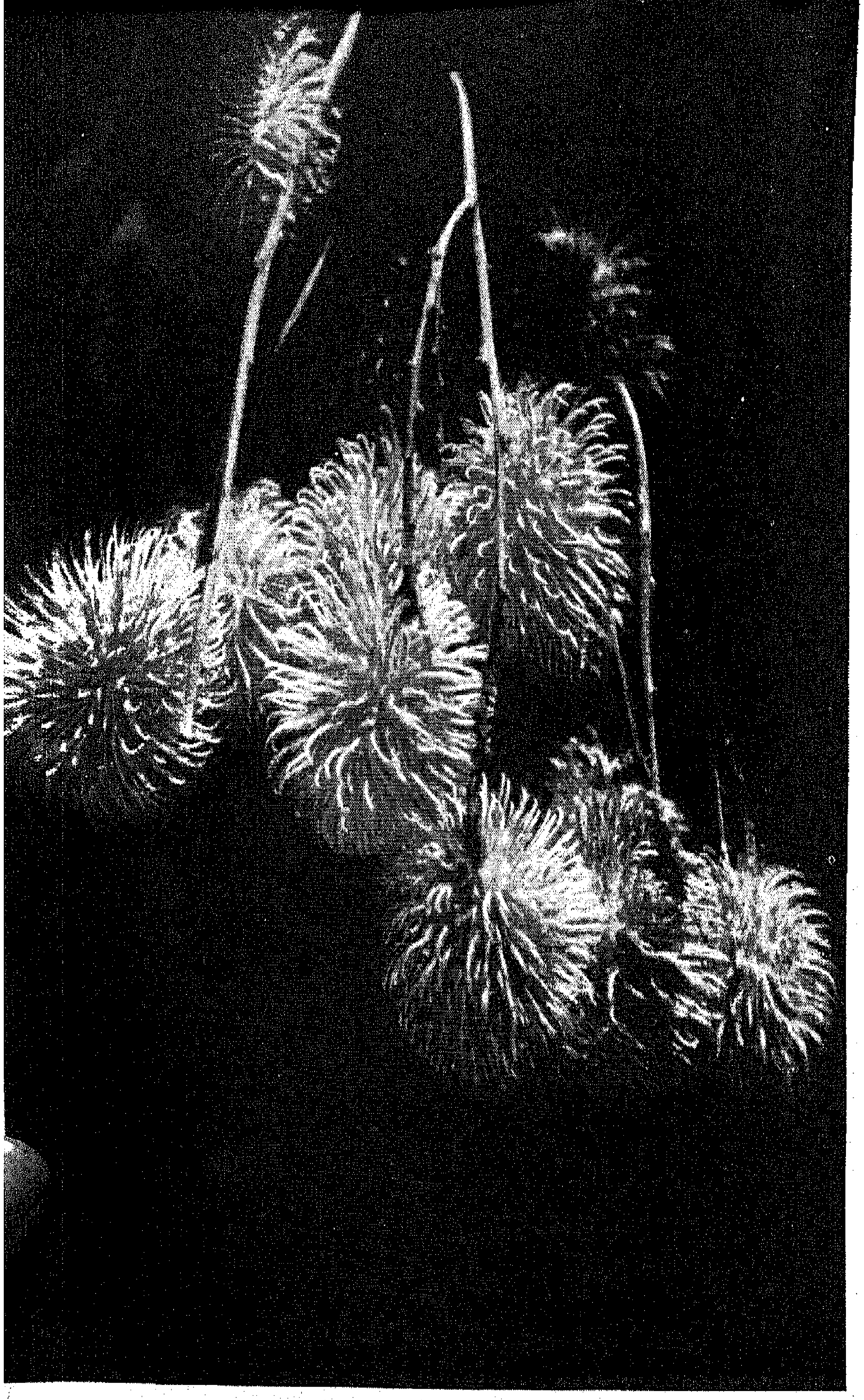


Plate 11. RAMBUTAN (*Nephelium lappaceum*)
(*page 131*)

around the turn of the century. In India it is grown only for its fruits, but in other countries the milky latex from the bark of the tree yields an important commercial product, gutta percha, which forms the base for the manufacture of chewing-gum.

In India, the main centres of its cultivation are the area between Bombay city and Surat, the coastal areas of Andhra Pradesh around Vishakhapatnam, Madras, Mysore, Saurashtra, the submontane areas of U.P. and Bengal.

It is a tropical fruit which likes a warm, moist weather. It thrives in places where the maximum and minimum temperatures do not go beyond 34°C and 11°C, respectively. It does not like a hot dry summer. It can be grown in places where the temperature touches the freezing-point only for short periods. It is grown on hills in South India up to a height of 1,000 metres, but it does not do very well above 500 metres. It thrives in areas with 100 to 150 cm. rainfall. It can grow in a variety of soils, but in sandy soils the plants are uprooted by strong winds. If the soil is not well drained or a hard pan is present in the sub-soil the trees do not make good growth. It can stand the presence of salts in the soil or irrigation water to some extent. It is sometimes planted in dry river-beds with an alluvial soil.

Seedling trees have been grown in India in the past, as in some other countries. However, these trees show too much variation. Several methods of vegetative propagation are successful. Air-layering has become common in South and Western India. Layering is done in May-June and the detaching of plants is often delayed for a full year in high-rainfall areas where the layers are not hand-watered. In the Bombay area, there is a belief that air-layered plants give more granular fruits, but this statement seems questionable. In any case, the mortality after transplanting air-layered plants can be up to 50 per cent and some varieties do not layer successfully and plants inarched or side-grafted on 'Khirnee' or 'rayan' (*Mimusops hexandra*) are much more vigorous and high-yielding. This method of propagation is becoming very popular. The 'mohwa' (*Madhuka latifolia*) root-stock is not very promising for this purpose. Propagation by ground-layering, which takes rather a long time, and the Forkert method of budding as followed in the case of mango is also feasible.

Sapota is often planted 5 metres apart in India. This distance is too close and a distance of 8 to 9 metres is recommended. The planting is done in May before the rains start. After planting, the young trees are staked to protect them from winds and are often covered with coconut leaves to give protection from the sun. Sapota requires little pruning. Young trees require heavy irrigation but cannot withstand stagnant water. However, on the West coast of India, where rainfall is heavy, no irrigation is required and on the East coast watering is done in the dry months only. In coastal Gujarat, a half-metre-high mound of earth is prepared around the trees to save them from bending under the impact of strong winds and to conserve moisture. Irrigation is done in a ring around the mound. A similar practice is followed in the case of mango in Ratnagiri district, south of Bombay.

It also requires good manuring. Banana which requires extremely high doses of manure, is often inter-planted with sapota. The sapota, thus, gets heavy fertilization indirectly. Banana pseudostems are added to the soil around the sapota trees after decomposing them. Without manuring the bearing of the trees becomes poor after some years. Application of superphosphate improves the size of fruit in old orchards.

Grafted sapota trees begin to bear fruit after three years. Since it is a slow-growing tree, the yield continues to increase up to 30 years, after which it declines. The yield varies from 1,500 to 3,000 fruits per adult tree. The representative figure is 2,000 fruits. In a variety like Cricket Ball, which has very large fruits, the yield may be only 500 fruits. Sapota flowers almost throughout the year under tropical conditions, but there are two main seasons of peak fruiting from March to May and September-October. The fruits ripening in summer are generally sweeter. In the Bombay area, the main season is December to March. In stray plants, pollination can sometimes be a problem due to self-unfruitfulness.

The fruits are harvested when they have developed good bloom on the surface, but are still firm. Sapota fruit has good transport and keeping qualities. It is astringent till fully ripe, as in the case of some varieties of persimmon. Sapota fruits ripen well after harvesting, but if they are harvested too unripe, the milky latex coming out of the cut stem spoils the appearance of the fruit. The fruits ripen well at a temperature of 52°F to 56°F. Ripe fruits can be kept in cold storage at 32°F to 35°F for 6 weeks and firm fruits at 35°F to 38°F for 8 weeks.

Many varieties of sapota are known in different parts of India. These are divided into two main groups, one having round fruits and the other oval fruits. Unfortunately, this character is not stable. The same variety can produce round and oval fruits at the same time. Different fruit-shapes predominate in different seasons. The important varieties are Kalipatti and Chhattri in the Bombay area, Pala, Dwarapudi and Kirthabarthi in Andhra Pradesh and Cricket Ball in Madras and Bengal.

Kalipatti has predominantly oval fruits of outstanding quality. They are borne singly and are harvested in winter. The leaves are dark green. Chhattri has light green leaves and branches spreading horizontally in whorls like an umbrella. The fruit quality is not as good as that of Kalipatti. The fruits of Pala are oval, thin-skinned and are borne in clusters. The fruits of Kirthabarthi are egg-shaped, very sweet, and have a rough, thick skin. They can stand transport well. Dwarapudi has sweet large fruits. Cricket Ball has largest fruits, which are gritty and not very sweet. Some people consider this variety to be the same as Calcutta Large.

Sapota is comparatively free from pests and diseases. The most serious insect pest is the caterpillar, *Nephopteryx eugraphella*, which feeds on buds, leaves and young fruits. It is controlled by spraying calcium arsenate. It also attacks plants of *Manilkara elengi*. Other pests include the stem-borer (*Arbela tetraonis*), mealy bugs (*Phenacoccus icerjoides*), scale insects (*Pulvinaria psidii*), a fruit-borer and bark-eating caterpillars.

MINOR TROPICAL FRUITS

Some of the tropical fruits are very exacting in their requirements. They not only cannot stand cold weather, but are also susceptible to injury from dry winds and a strong sun and require a moist climate and plenty of irrigation throughout the year. Their cultivation is thus extremely localised. These are fruits of recent introduction from the east and are cultivated at the foot of the hills in South India. The experimental orchards at Kallar and Burliar at lower elevations of the Nilgiri Hills near Coimbatore have an excellent collection of such fruits. In the shady, cool and moist gullies with plenty of water found here, the mangosteen and durian grow side by side with litchi, rambutan, avocado and carambola. Unfortunately, these lush green pockets also attract wild elephants, which often damage the plantations.

The best among these fruits is the mangosteen, *Garcina mangostana*, belonging to the family Guttiferae. It has nothing to do with the mango. It grows abundantly in Ceylon and from Burma to the southern part of the Philippine Islands. In India, it grows on the lower slopes of the Nilgiri Hills and in Tinnevelly district of Madras State. It is a very delicious fruit. The fruit is the size of a sapota and has a hard shell inside which there are three to five seeds, each covered with a thick, white, melting pulp with an exceptional aroma. These fruits have a ready market and are shipped by air against prior orders. The evergreen tree with large shining leaves is most beautiful to look at. It requires heavy irrigation or rainfall and plenty of organic matter in the soil. It requires protection from winds.

The mangosteen is unusual in some ways. It produces the fruits parthenogenetically, which means that the female part of the flowers produces seeds without fusion with the male parts. The plants raised from seed are, therefore, exactly like the mother-tree. The original roots of the seedling die soon and a new set of roots arising from the base of the stem takes their place. This change-over to the new root-system slows down the growth of the seedlings during the first few years.

The roots of the mangosteen do not possess any root hairs. Propagation is usually done by seedlings, but these take from 10 to 20 years to start fruiting. Grafting is done in Ceylon. Inarching on seedlings of *Garcinia tinctoria* seems to be promising. Seeds of large size sown immediately after harvesting of the fruit give better germination. The transplanting of the seedlings should not be delayed, otherwise the roots which go deep are damaged. The trees should be planted about 10 metres apart. Flowers are borne on shoots, which are more than two years old. Therefore, this evergreen tree does not require any pruning of healthy branches. The young trees require shade during summer.

The main fruiting season is August-September. The same trees give a second crop in March-April. The average yield per tree is 200 to 400 fruits in India, as compared to 500 to 1,500 fruits per tree in other countries. Other species with edible fruit found in South India are *G. indica*, *G. tinctoria* and *G. cambogia*. Their fruit quality is poor, but they may be useful for canning.

The two serious drawbacks of this delicious fruit are that the trees take many years to come to bearing and the physiological disease called gamboge. It turns the white pulp yellowish, sticky, and unpleasant. No control for it is possible so far.

The Durian, *Durio zibethinus*, belongs to the family Bombacaceae, to which also belongs the silk cotton tree. The fruit weighs up to 4 kg. and its surface has spiny projections like the jack-fruit, to which it is not related. It is probably a native of Borneo, but is very popular in Burma. The tree is very tall and a falling fruit is a dangerous object. The Durian is a very popular, but controversial fruit. It has a very strong unpleasant smell, which can be ignored by only those who have grown up in the midst of this fruit. It is said that the smell can be removed by keeping the pulp dipped in coconut milk for a day. This, however, is not a simple remedy. Like the mangosteen, it requires a warm humid climate, plenty of soil moisture and a rich soil. The usual method of propagation is by seed. Inarching has been found successful in South India, but it is a long and laborious process. It takes as long to come to bearing as does the mangosteen. One tree yields about 50 fruits per year during the months of July to September.

The carambola or 'Kamrakh', *Averrhoa carambala*, belonging to the family Oxalidaceae, is a tropical fruit native to Malaya. It requires a warm moist climate and is grown mostly on the West Coast of India and on lower hill-slopes of South India up to an altitude of about 1,000 metres. It can stand very little frost and is found in other parts of India where this hazard does not exist.

The tree is about 10 metres tall, and bears succulent fruits, which are about 7 cm. long and most prominently ridged. There are no established varieties, but two types of fruit are found. The sweet type is liked in China. The sweet types found in India are in fact insipid. The sour types are popular in South India as a substitute for tamarind in cooking. It is rich in vitamin C, and minerals like calcium, magnesium and phosphorus. It is propagated from seed. Inarching on seedling root-stocks is very successful. Layering, shield-budding or Forkert-budding is also practicable. The trees are planted five to seven metres apart. The peak seasons of harvesting in South India are January-February and September-October. In North India, the fruits ripen in winter or spring. The average yield is estimated at 50 to 100 kg per tree.

The cucumber tree, *Averrhoa bilimbi*, is a related tree, which is more tropical. The fruit is very sour, about 2 cm in diameter and about 5 to 7 cm long. The ridges on its surface are obscure. The fruit is borne in clusters on older branches. It has smaller, more numerous and hairy leaflets.

Another fruit which has been introduced from Malaya into this locality is the langsat (*Lansium domesticum*). The fruit is of a good quality and may prove successful.

CHAPTER IX

OTHER SUB-TROPICAL FRUITS

LITCHI

THE LITCHI, lychee, lici or licy is indigenous to the southern part of China and seems to have reached Eastern India by the year 1800. The cultivation of this fruit has become very popular in South Africa, especially in Natal and the Transvaal. South Africa exports litchi to the U.K. After China and South Africa, India is the next important country for litchi production. This sub-tropical fruit is very fastidious about its climatic requirements. In India the State of Bihar, especially the Muzaffarpur district, has almost a monopoly of litchi production. The area under litchi in Bihar is close to 1,000 ha. The Dehradun Valley at the foot of the Himalayas in Western U.P. and Assam have an area of about 150 ha and 200 ha, respectively. A few trees are also found in humid parts on the hill-slopes in the Nilgiris up to a height of about 1,000 metres. In West Bengal, it is planted on a limited scale in wet lands along boundaries of fields. The water here is not stagnant and keeps moving constantly.

The litchi, *Litchi chinensis*, belongs to the botanical family Sapindacea, to which also belongs the soap-nut tree, found growing commonly in the lower Himalayas. The litchi is a delicious, juicy fruit, which comes to the market in May-June in North India, when no other fresh fruit is available except a few plums, etc., from the hills. Local mangoes are not ready at this time and litchi fetches a fancy price.

This sub-tropical fruit cannot tolerate frost in winter and dry heat in summer. Its cultivation in the Indo-Gangetic plain is almost entirely limited by the presence of hot desiccating winds in summer. Under these conditions the tree makes poor growth and fruit-cracking is a very serious problem. On transplanting in the field, the mortality of the tree is very heavy under these conditions.

The young trees suddenly shed all their leaves in the hot weather. They cannot be saved after this has happened.

It is not fastidious about its soil requirements and can stand almost any soil, but it makes best growth in deep loam. It requires good drainage of soil. In Bihar the litchi soils have a high lime content. In the ancient Moghul garden at Pinjore on the way to Simla, there is an excellent plantation of litchi at the foot of the Himalayas. This place is not free from the hot dry summer winds, but the trees are planted within a high boundary wall and are thus sheltered from the winds. In this place, some sporadic trees have now started yellowing. This is probably due to poor drainage of the soil or the presence of rocky sub-stratum in the soil. The soil should be very well drained.

Litchi can be propagated vegetatively quite easily, but these plants do not have as good a root-system as the seedlings, and their survival after transplanting is a problem. The most widely established method of propagation in India is ground-layering. It is a somewhat slow method and the plants are expensive, but very successful. Air-layering with the use of plastic wraps is easy and is becoming important. In this method, roots are formed easily. The roots are thick and break easily and the plants have low survival after transplanting. In this method, a 2.5-cm. wide ring of the bark is removed about 50 cm below the tip of a shoot and the cambium layer is thoroughly scraped from the exposed wood. The cut is treated with a plant-growth regulator, covered with sphagnum moss and tied over with a plastic wrap. The operation is performed in the beginning of the monsoon and the air layer can be detached from the mother-plant after 60 to 70 days. After this the young plants are set in a pot and kept in partial shade for several months. This gives better survival after transplanting. In another method followed in Bihar, after removing the bark the cut on the branch is covered with a mudplaster rich in nutrients. It consists of 80 parts of mud from the bottom of a pond, 20 parts of sand, 10 parts each of rotted gunny sacks and rotted castor cake and one part of ammonium sulphate by weight. The mixture is kept for one week after mixing. The air layer is prepared in August, covered with this mud and then with straw. It is covered with a second layer of this mud after one month.

Propagation by inarching and grafting can also be done. The seeds of the root-stocks should be sown immediately since they lose their viability if they remain dry for three or four days. Cuttings from two-year-old wood can be made to root if treated with a solution of 50-100 mg of IBA (indole-butyric acid) in one litre of water or if propagated in a mist chamber. However, they do not grow well. Chip-or shield-budding and veneer-grafting are successful in Hawaii and the Philippines.

The handsome litchi tree with its shiny evergreen leaves is slow-growing, but finally it becomes quite large. Under normal conditions, it should be planted 10 metres apart. Where hot winds are serious, the trees should be planted only 8 metres apart. The planting distance in different parts of the world varies from six to 16 metres. The pits should be heavily manured before planting in order to hasten the growth of the young trees.

An interesting feature of the litchi plant is the symbiotic growth of mycorrhizal fungi on the roots of the trees. Just as bacteria live on the roots of the leguminous plants like the Egyptian clover and fix nitrogen from the air present in the soil, these fungi perform the same function in litchi. These fungi form nodules on the roots of litchi. The trees and the fungus live together to the benefit of each other. To ensure that the new plants carry the fungi, they should be propagated or potted in soil taken from under old litchi trees. The young litchi plants are very sensitive to frost, especially when actively growing. They must be protected with a covering of thatch for several years in places where there is danger of frost. Litchi is a shallow-rooted tree and should not be given deep tillage. Use of a mulch or chemical weed control without tillage is likely to prove beneficial for litchi.

Manuring and irrigation are the two most important considerations in the upkeep of a litchi orchard. In Bihar, generally no irrigation is given to bearing trees because of sufficient retention of moisture in the soil and high atmospheric humidity during the fruiting season. However, in other areas regular irrigation from

February to June is necessary. The Chinese apply 250 kg of night soil per tree. In India litchi is grown on fertile soils and manuring is generally neglected, but an application of 10 to 250 kg of farmyard manure per annum per tree depending upon its age is recommended. Apart from nitrogen, litchi also definitely requires potash and phosphorus. The deficiency of zinc is also experienced. It seems to turn the leaves bronze-coloured. It can be corrected by spraying 4 kg of zinc sulphate and 2 kg of hydrated lime dissolved in 500 litres of water.

The evergreen litchi plant requires hardly any pruning. The bunches of fruit are harvested along with a part of the shoot. This seems to promote enough growth of the shoots for fruiting in the following year.

Vegetatively-propagated litchi trees start bearing after six years. Since the tree is slow-growing, the yield continues to increase for 20 years. The litchi fruit is covered with a thin hard skin, which is covered with sharply-pointed tubercles. The fruit is harvested for distant markets when its colour begins to turn pinkish and the tubercles become flattened. Harvesting the bunches with part of the shoot and leaves is said to delay its wilting. In India, the fruits are packed in shallow baskets, not more than 25 cm. deep. The brilliant pink colour of the fruits turns brown a few days after harvesting. The yield per tree is 80 to 150 kg in India. In this country the bearing is regular and annual. In places like Hawaii, the trees are sprayed with NAA (alpha-naphthalene acetic acid) in autumn to promote flowering and fruiting next spring. Girdling of branches at the same time is also reported to increase yield.

The fruit does not last more than a few days. It can be kept successfully in cold storage for three months at a temperature ranging from 30°F to 45°F. The Chinese also store it in salt solution inside bamboo stems. In China, the litchi is dried along with the skin. The dried flesh and the seed rattle inside the hard shell and the product is called litchi-nuts. Chinese all over the world are fond of these. In India litchi is not dried, but canning has been started.

The important varieties of Bihar are China, Purbi, Dehra Rose, Bedana and Desi. In U.P. the varieties Calcuttia and Mcleen are heavy-bearing. Rose Scented, Early Large Red and Late Seedless are also important. The seedless types require pollination for developing fruit. The seeds are very small, but the seed is definitely there. The pulp of the litchi is an outgrowth of the seed, to which it is attached on one side. The development of a completely seedless fruit is, therefore, not possible. The variety Pyazi is queer and has the taste of boiled onions. In the Hooghly district of West Bengal, the important varieties are Muzaffarpur and China. In the variety Bombai from Bengal, every fruit has another tiny undeveloped fruit attached to the fruit stalk, as in the case of the Chinese variety Hom-shiu-Chi.

Litchi does not suffer from any serious pest or disease in India. Protection from birds is the most serious problem. In vigorous growing young trees, the leaves may become thick and curl up due to an attack of a mite (*Eriophyes* sp.) Apart from other insecticides 0.05% parathion spray can control it. The bark-eating caterpillar (*Indarbela* sp.) and a scale (*Parlatoria pseudopyri*) have also been reported. In U.P., the caterpillar, *Lymantria mathura*, which is a pest of mango, has been observed to damage litchi.

A type of the litchi which is more cold-hardy and found in the mountains belongs to the same species, *L. chinensis*. A few other minor fruits similar to litchi are also found in India. The longan, or 'ashphal', *Euphoria longana* is indigenous to the Western Ghats and grows wild at elevations up to 1,600 metres. It is also found in Bengal and Assam at elevations up to 1,000 metres. It is an inferior fruit of a smaller size, with a large seed and a smooth skin. It ripens later than litchi and can be canned into an acceptable product. Its tree is larger than the litchi tree and can stand a cooler weather. It is often propagated by inarching. A few trees of rambutan (*N. lappaceum*) are found on the hills in South India. The fruit is yellow-coloured with sharp spiny projections, as are found in castor. The flesh is united with the seed. Some people like its fruit more than that of litchi. The 'latka' of Bengal (*Pierardia sapida*) is a small tree indigenous to Assam, Bengal and Burma. The fruit is yellow with the skin resembling that of loquat.

BER

The Chinese date, Chinese fig, ber or bor is an important minor fruit of India. It is the most hardy fruit-tree cultivated all over India and is often called the poor man's fruit. Most of the trees grow isolated, are of poor quality and their fruit sells cheap. However, many plantations of budded trees have now come up all over India, and fetch higher prices than even grafted mangoes. These Indian varieties are not as rich in sugar and vitamin C as the good Chinese varieties. However, they contain 50 to 150 mg of ascorbic acid (vitamin C) per 100 gm of fruit and 12 to 18.7 per cent sugar. This is even better than the vitamin C content of the juice of sweet oranges. The candied ber also makes an excellent product. These superior varieties of ber are no longer the poor man's fruit. Ber is also used for rearing the insect *Tachardia laccad*, which yields lac (or shellac). This industry, however, received a setback after the gramophone industry started using discs of plastic instead of those made of lac.

Accurate statistics about the area under ber in India are not available, because regular plantations are a few. The important areas for ber cultivation are Bihar and Gujarat States, Assam, the southern parts of U. P., Haryana, Andhra Pradesh and Madras. Ber likes a hot dry climate found in the dry tropics and subtropics. It does not like a humid climate.

About the botanical identity of the Indian ber, there has been some confusion in the past. It belongs to the genus *Ziziphus* of the family Rhamnaceae, which is very close to the family of the grape, Vitaceae. Several species grow wild in India. These include *Ziziphus oenoplia*, *Z. rugosa*, *Z. xylocarnus* and *Z. rotundifolia*. The last one grows as a small shrub in wastelands in Rajasthan and many other States. It also grows as a weed in newly-reclaimed soils. Its fruits are very small and acrid and its leaves are fed to goats and sheep after drying. The cultivated Indian ber is very distinct from the Chinese ber, which belongs to the species *Z. jujuba.* The Indian ber has a spreading tree, vine-like branches, leaves which are dark green on the upper surface and densely felted on the lower surface, it flowers in autumn, bears fruits at the end of winter, if it sheds the leaves it does so in the hot weather after fruiting and does not like a cold climate. These characters are not found in the Chinese species. The Indian species is *Z. mauritiana.*

The Chinese species is difficult to propagate and is generally propagated by grafting, but the improved varieties of ber in India are easily propagated by ring-budding or by shield-budding in April to June. The root-stocks are generally sown directly in the field, since the ber has a tap-root, which is broken or twisted in transplanting. The hard stone around the seed is cracked, treated with concentrated sulphuric acid or stratified in moist sand at ordinary temperature for 60 days before sowing in order to facilitate germination. About 10 days after budding if the buds are green, the root-stock is cut off 10 cm above the bud-union. The buds sprout after three weeks. When the new shoot arising from the bud is 15 cm long, its tip is pinched off to encourage the growth of the laterals for building a proper frame-work of the tree. Trees from which the budwood is to be obtained should be pruned in February or March. Stout new shoots with good budwood are ready after about 60 days. Seedling trees of *Z. maruitiana* are generally used as root-stock, but seedlings of *Z. rotundifolia* (Malha, Jharberi or Chanibor) can also be used. Old inferior varieties of ber can also be successfully top-worked. The trees are severely headed back in February and a few of the new shoots are budded after about 60 days. The trees are often planted 6 to 7 metres apart, but the distance should be increased to double this length.

The ber can grow in almost any soil even under conditions of neglect. Even under these conditions, some of the seedling trees attain a height of over 20 metres. It can also grow in slightly alkaline or water-logged soils.

Although ber is a very hardy tree, it responds to good care. In Gujarat 20 to 30 kg of farmyard manure is given to each tree. Sometimes 1 to 2 kg of common salt is also applied to each tree, as is sometimes done in the case of mango. This practice seems pointless and should be definitely discouraged. Irrigation of the young trees during the hot weather, especially of the root-stock before budding, is very desirable. It hastens growth and makes budding easier and surer. No regular tillage is, however, given to plantations of ber. Training of the young trees to give them a strong framework with the main branches well spaced and rising not too high is important. Some annual pruning of the old trees is necessary. It encourages the growth of new shoots to increase bearing. Weak branches are removed. Some authorities recommend pruning every other year. The pruning is done after harvesting the fruit. Another light pruning can be given shortly before flowering. Trees on *Z. rotundifolia* root-stock are pruned severely and are cut back close to the bud-union.

The fruit is harvested from November to March in different parts of the country. The yield of the superior varieties varies from 40 to 90 kg per tree. There are several varieties in different parts. Narma and Karaka are famous varieties of Benares in U.P. Umran or Umri is a large-fruited variety with a good yield and a good keeping quality around Delhi. Gola is a very early, round-fruited variety of excellent quality exclusive to Delhi. Unfortunately, it does not have a good transport or keeping quality. Dandan, Kheera and Chonchal are other good varieties of this area. Kotho or Katha from Alwar and Meherun ber from Jalgaon in East Khandesh are said to be resistant to fruit-flies. A seedless variety of ber was found in Poona, but it has not spread probably due to the small size of the fruits.

Birds attack the fruits of ber as much as they attack the guavas. During the fruiting season, the ber trees are covered with fishing nets in some places to protect them from birds. The biggest menace to ber cultivation all over India, however, is the attack of fruit-flies, *Carpomyia vesuviana*. It makes the fruit unfit for sale. The flies may ruin up to over 90 per cent of fruit. The attack on different varieties may vary from 2 to 100 per cent. The early varieties with large sweet fruits are attacked more. Burying the infested fruits, ploughing the soil under the trees and spraying 0.1 per cent chlordane or DDT after October every year is able to check the attack. The fruit-borer, *Meridarchis scyrode*, found in South India can be checked with BHC. This treatment can also control *Porthomologa paraclina*, which damages the leaves. Other insect pests found in India are *Thiacidas postica*, *Tarucus theophrastus*, *Myllocerrus transmarinus* and *Xanthochelus superciliosus*. The only noteworthy disease of ber in India is the powdery mildew caused by a species of *Oidiopsis*. It has been reported from Western U.P. and can cause shedding of fruits. It can be controlled with lime sulphur wash. Other fungal diseases noticed in India are *Mitterellia ziziphina* and a species of *Cercospora*.

POMEGRANATE

The pomegranate is an ancient and important fruit. It is symbolic of plenty and a basket of pomegranates has been chosen as a symbol of the 18th International Horticultural Congress to be held in 1970. It is a popular fruit and according to latest figures constitutes over 20 per cent of the fresh fruits imported in India. Pomegranate, *Punica granatum*, belongs to the smallest botanical family, Punicaceae. It is cultivated mostly around Poona in Maharashtra and Dholka in Gujarat, and to a limited extent in U.P. It grows all over India, but thrives best in places with a hot dry summer, provided irrigation is available. In humid weather, the quality of fruit is not good. It can stand considerable frost and grows up to an altitude of 1,600 metres. A wild type called 'Daru' grows abundantly in the lower Himalayas. Its fruit is not edible, but the dried seeds give an important condiment called "anar dana". The edible part of the pomegranate is the juicy outgrowth of the seed called the aril. The sour arils of the wild type, when dried along with the seed, give the "anar dana" its flavour. Where the winter is cold, the tree is deciduous, but in the plains of India it is evergreen. It can tolerate alkaline and wet soils.

Many pomegranate plantations in India have been raised from seedlings as in the case of guava, but the seedlings vary too much.

Propagation from hard wood cuttings is easy. Layering is also possible. The planting distance is generally not adequate. Some plantations have trees as close as three metres. However, a distance of six metres from tree to tree is necessary.

The fruits are borne terminally on short spurs arising from mature shoots. These bear fruit for three to four years. Only a limited pruning of the bearing tree is, therefore, required. The gradual growth of new shoots should be encouraged by restricted cutting back of the bearing shoots. Suckers are removed regularly.

Pomegranate flowers in spring in North India, but in Central and South India it flowers almost throughout the year. However, the flowers are most profuse early in the monsoon season. The spring flowering (*Ambe bahar*) gives fruits in summer, when the demand is maximum. However, the fruit quality is poor. Flowering is, therefore, artificially induced early in the rainy season, as in the case of citrus. For this purpose, the roots are exposed in April and manuring and irrigation are done in May. After this treatment, the fruits ripen in November-December.

There are many types of pomegranate, including the double-flowering, ornamental type and a white-flowered type. The latter has a very poor fruit quality. In the cultivated types, the sugar content varies from 12 to 16 per cent and the acidity from 1.5 to 2.5 per cent. Dholka is the important variety of Gujarat. It has white flesh and soft seeds. In the Poona area, the variety Alandi or Vadki, with deep pink flesh and hard seeds, is important. A selection from this variety with soft seeds is Ganeshkhind No. 1. An introduced variety, Paper Shell, with soft seeds and pink flesh has been found successful in South India. Bedana and Kandhari have been reported satisfactory from Himachal Pradesh. The yield in different parts varies from 50 to 200 fruits per tree.

The most serious problem of pomegranate cultivation in India is the splitting or cracking of fruit. Sometimes more than 50 per cent of the fruits are cracked. It is due to the hardening of skin of the fruits during periods of shortage of moisture and then sudden expansion of the inner part of the fruit after rain or heavy irrigation. The fruits are often harvested prematurely to avoid fruit-cracking,

Plate 13. A FRUITING BRANCH OF PHALSA (*Grewia subinaequalis*)
(*page 142*)

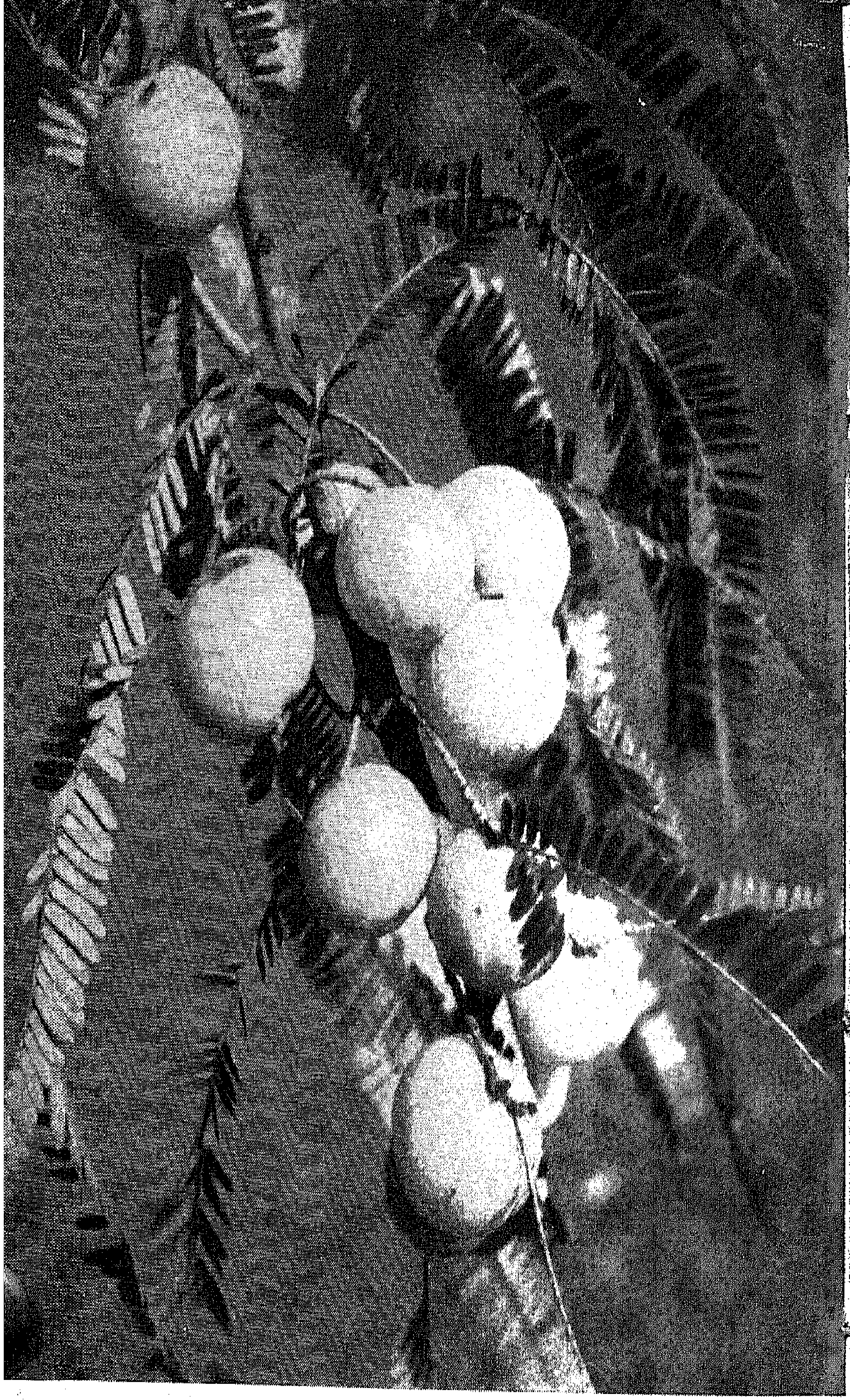


Plate 14. AONLA (*Emblica officinalis*)
(*page 144*)

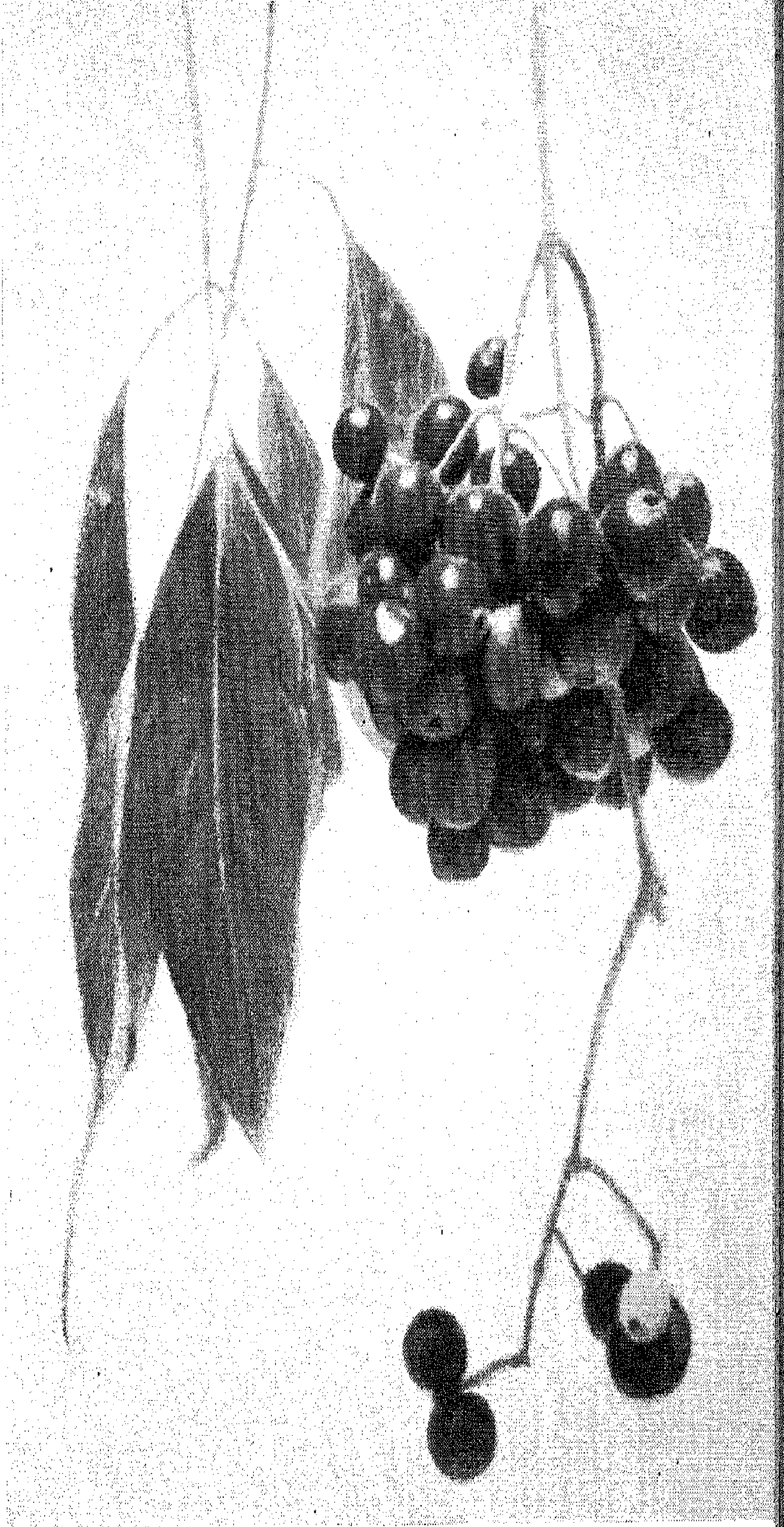


Plate 16. WILD JAMAN (*Syzygium fruticosum*)
(*page 147*)

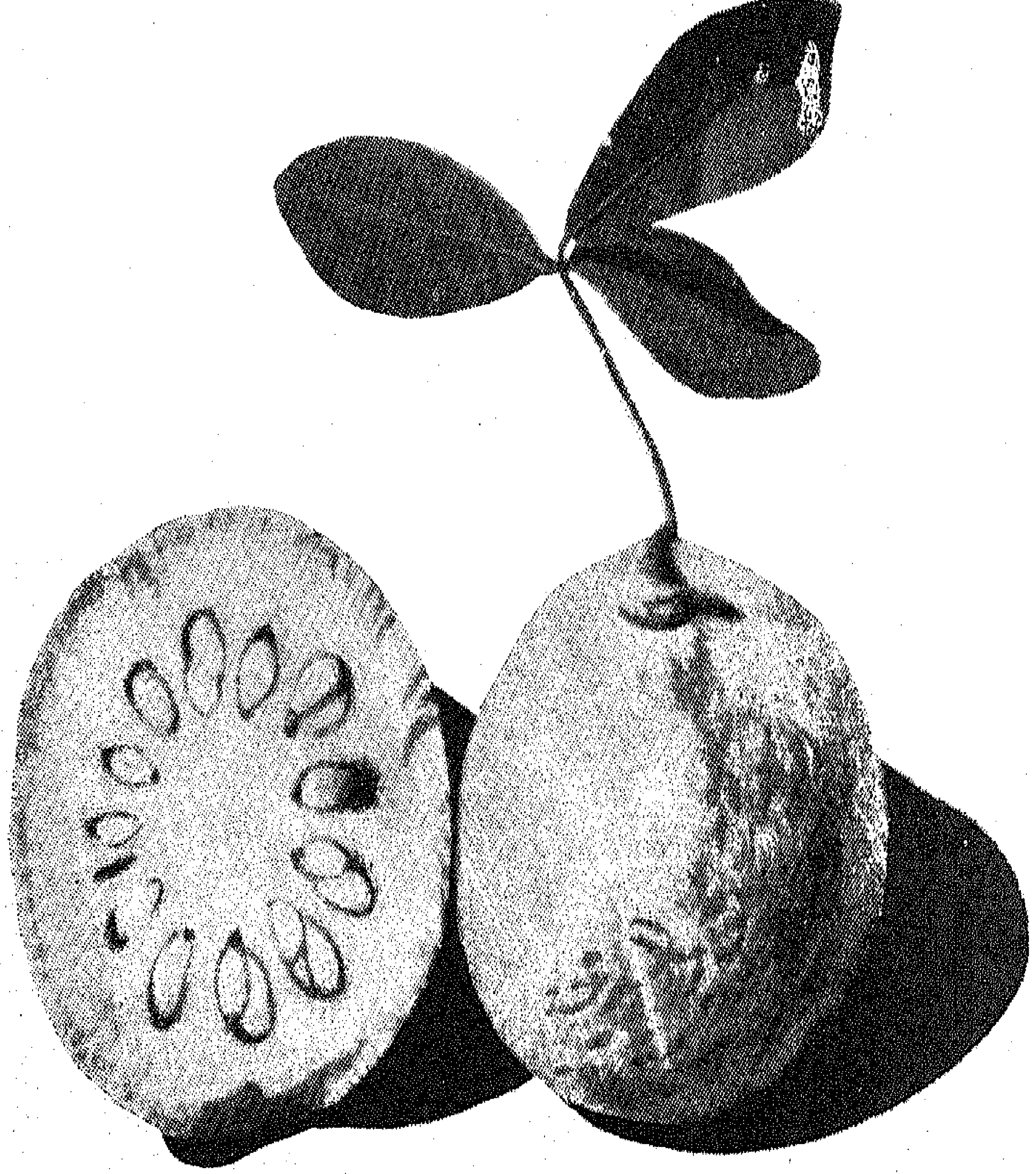
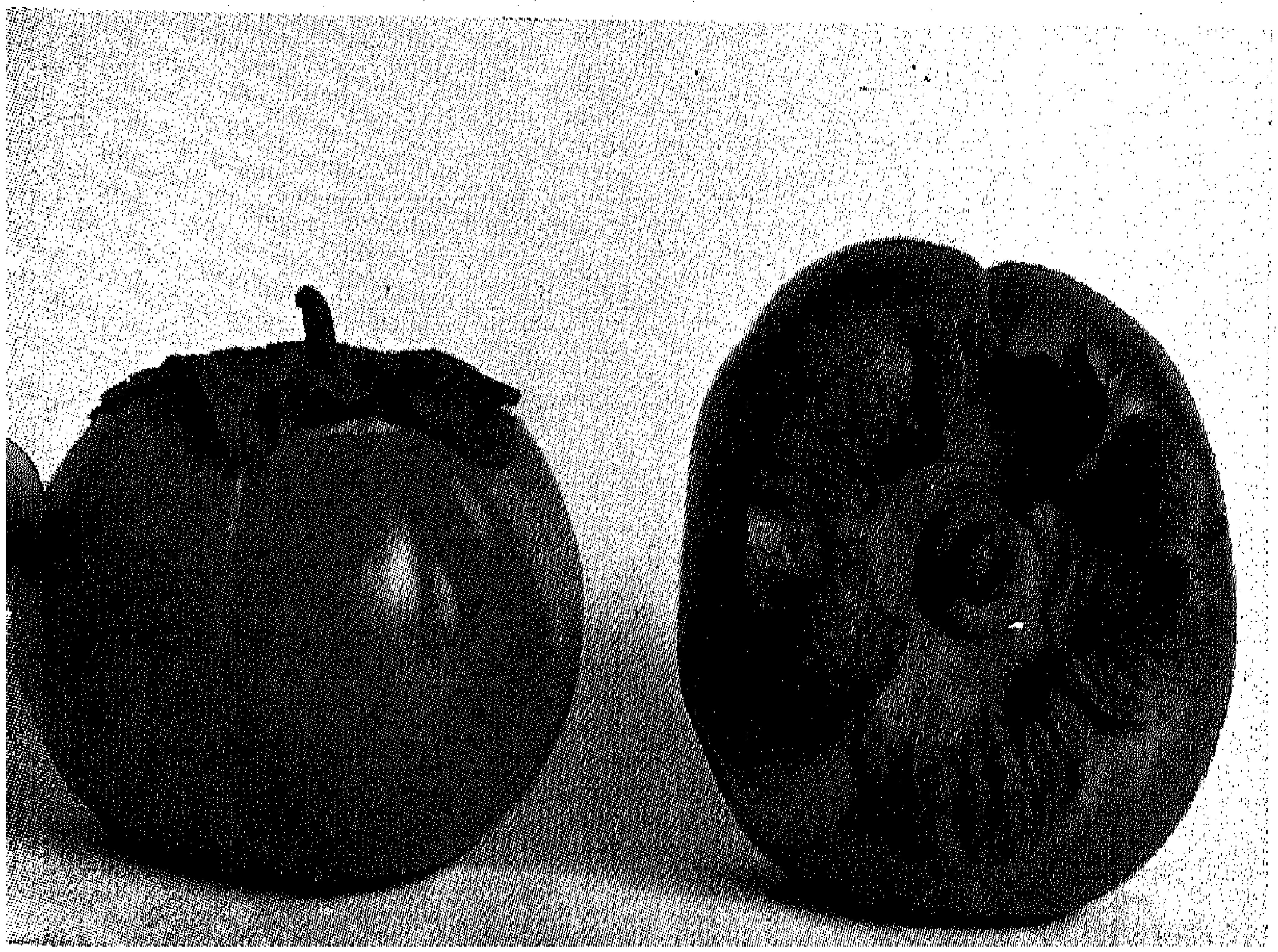


Plate 15. WOOD APPLE (*Feronia limonia*) (*page 146*)

Plate 20. FUYU PERSIMMON (*Diospyros kaki*) (*page 167*)



but the fruit quality is very poor in this case. No cure of the trouble is known so far. The trouble can be minimised by improving the water retention capacity of the soil by adding organic manure to it and by regular and light irrigation throughout the fruiting season. Some people add powdered bricks to the soil with the belief that it would improve colour of the fruit and the flesh. There is no more justification for this than in the practice of adding milk to the roots of mango to make it sweet and creamy. However, this practice probably reduces fruit-cracking by improving the moisture-retaining capacity of the soil.

Another menace to its cultivation is the attack of the anar butterfly (*Virochola isocrates*) which bores the fruit. The affected fruits develop a rot. Spraying with calcium arsenate after fruit-set or dusting two or three times a month with a mixture of Paris green (9 lb.), lime (5 lb.), talc (15 lb.) and flour (4 oz.) has been recommended. DDT and BHC are not effective. Another caterpillar, *Epijarbus ancus*, has also been reported. Another pest found in India is the bark-eating caterpillar (*Aleurodes* sp.).

LOQUAT

The loquat (*Eriobotrya japonica*) has come to India from Japan, where its cultivation has developed greatly. All our varieties are believed to be of Japanese origin. However, it is believed to have actually originated in China, from where it went to Japan. It belongs to the family Rosaceae to which all important temperate fruits and the rose belong. Botanically, its fruit is a pome, consisting of five carpels united and covered by the edible portion of the fruit consisting of an extension of the stalk of the fruit. The apple, pear and quince also have the same type of fruit. It is, however, an evergreen sub-tropical tree. On account of its close relationship to these plants, the quince, apple and pear can be used as rootstocks for the loquat. This practice is, however, not followed in India. An unusual feature of the loquat is that, whereas most other fruits flower in spring in the North Indian plains, it flowers from July to December. One reason for the popularity of this fruit is that it comes to the North Indian markets in April, when few other fruits are available. Other species of *Eriobotrya* occurring wild in the Eastern Himalayas include *E. angustissima*, *E. dubia* and *E. bengalensis*.

It grows well in the Mediterranean area but can stand considerable frost and tropical heat. However, it does not fruit well under these conditions and is grown only as an ornamental tree.

The area under loquat in India is about 1,300 hectares. The submontane area of U.P. is by far the most important area for loquat. This State has about 800 hectares under loquat. It is also grown in the Punjab, Delhi, Assam, Gujarat and the hills of South India.

Whereas it can be grown in a variety of climatic and soil conditions, it must have a good drainage of soil. In Delhi during two successive years of heavy rain many loquat trees were killed outright in poorly-drained soils. A well-drained loamy soil is best suited for loquat.

In India loquat is generally propagated by inarching as practised in the case of mango, but shield-budding on seedlings of loquat is much easier. The best time for budding is February, but it can also be done in September-October. Ground-layering and air-layering with the application of 3 per cent NAA (a plant hormone) is also possible.

The trees are planted eight metres apart. They should be heavily manured. The general practice is to apply 100 kg of farmyard manure per bearing tree. Application of potassium is also advisable. Irrigation during the fruiting period is important. Training of the tree to build a proper framework is not necessary. However, the bearing tree, unlike other evergreen trees like mango and citrus benefits from annual pruning to regulate crop. The flowers are borne mostly from July to August. After this sparse flowering may continue up to January. However, the flowers appearing in October-November give the best crop. So the branches should be snipped off two inches below the tips towards

the end of May. This encourages growth of new shoots which flower not in July-August, but later in October-November. This increases the yield greatly. Removal of some fruits improves the size of fruit. The average yield per tree is 16 kg.

Many varieties of loquat are cultivated in India. The colour of their fruit and flesh varies from pale yellow to orange. The taste also varies considerably. The varieties include Golden Yellow, Improved Golden Yellow, Thames Pride, Large Pale Yellow and Large Agra. California Advance and Tanaka are late varieties.

The diseases found on loquat include the stem brown caused by the fungus *Botryosphaeria ribis*, which is serious on apple, and the die-back disease caused by *Macrophoma* sp. It enters through the pruning wounds, which should be painted with Chaubatia paste (red lead 4 parts, copper carbonate 4 parts and lanolin 5 parts). There is no serious pest of loquat in India.

FIG

The fig (*Ficus carica*) belongs to the family Moraceae, to which also belong the mulberry and jack-fruit. The genus *Ficus* includes the peepal tree (*F. religiosa*), the banyan (*F. bengalensis*), the pilkhan *F. lacor* (*F. infectoria*), which is often used as a highway tree and the Indian rubber tree (*F. elastica*), which is used as an indoor green plant. Several species of *Ficus* are found growing wild in India. These include *F. cunia*, *F. pumila* and *F. rumphii*. In the plains of North and South India as well as the hills some wild figs are also found. These species indigenous to India include *F. glomerata*, *F. hispida*, *F. auriculata* and *F. palmata*. Their fruits are edible, but of a poor quality. However, the commercial cultivation of fig is not well developed in India, even through imported dried figs have a ready market.

The main areas of fig cultivation in India are Poona, Srirangapatnam in Mysore State, Lucknow in U.P. and parts of Gujarat. Poona area is the most important, but the area under fig here has come down from over 400 hectares to about 120 hectares. This has been caused by the rust disease, which attacks the fig leaves.

The fig is more sensitive to climatic conditions than to soil. It is a deciduous tree, which does not have a definite chilling requirement in winter. It does not like high rainfall or humidity and in Central India the figs go into dormancy during the rains, and shed almost all their leaves. They start new growth in October, whereas in North India winter is the dormant season for them. Climate influences the quality of the fruit, which is best in a warm dry weather. A dry locality with irrigation facilities is good for fig cultivation but temperature above 39°C causes sunburn of the fruit and also damages the trunk of the tree. Cold nights make the fruit dry and hard, but fairly cool nights are desirable to make the fruit firm and sweet. Cold winds after a rain encourage the rust disease. The Smyrna type of fig does not thrive in a cold winter, since it repels the wasp *Blastophaga*, which affects pollination in this fruit. This kind of fig is not found in India. Indian figs develop fruit without pollination. The seeds in the fruit are only hollow shells.

The fig grows in a variety of soils, but it does not like sandy soils, without the addition of sufficient organic matter and lime. The fruit quality is good on heavy soils. In sandy soils, the attack of nematodes is also greater.

Fig is generally propagated by hardwood cuttings all over the world. In India, the cuttings are two or three years old, 1½ to 2 cm. thick and have short internodes. They are planted in December to February in the North and in July to November in Central India. The cuttings are buried deep in the soil, covering even the topmost bud with some soil. The rooted plants are transplanted in the field after about 14 months. Propagation by air-layering or 'gootee', ring-budding and side-grafting on *F. glomerata* root-stock is also possible. This root-stock is reported to impart a good vigour to the plants. This is probably due to the resistance of this root-stock to the nematodes present in the soil.

Figs are generally planted about 4½ metres apart in India. This is less than the distance followed in other countries. In Mysore State, the distance is a half of the above and the trees are trained as bushes by severe pruning every year. In Madras the spacing is about 3½ metres. Figs are sometimes inter-cropped with papaya or planted as fillers in mango. Fig is fairly drought-resistant, but during summer, when the fruits are ripening, irrigation twice a month is common throughout India. This gives large and sweet fruits. More frequent irrigation makes the fruits insipid. Fig responds to heavy manuring and is sometimes irrigated with sullage water.

Pruning of fig is important. Small trees are easy to harvest. In Mysore the trees are headed back severely every year, leaving about two buds on each one-year-old shoot. In Madras and Poona, very little pruning is done. Shoots which have borne fruit are lightly headed back after harvesting. In the absence of adequate pruning, the fruit-bearing portion of the shoots moves away from the trunk every year. This can be remedied by shortening the main branches to a stump in winter. Large wounds do not heal quickly in fig and decay sets in. These wounds should, therefore, be painted after pruning. Notching is also practised to force new fruit-bearing shoots from the lower portion of the branches. For this purpose a half-cm wide notch of bark is removed above two buds on the middle portion of a branch in July. The notch is made slanting so that the latex from the wound flows away from the bud. Only a few growers practise this operation. In North India pruning is done in December. Each shoot of the previous season is cut back to three or four buds.

The fig bears two crops a year. The spring crop called breba is borne on the previous year's shoots. In Europe, the top buds of these shoots are cut off before spring. This is said to give early maturity and higher yield. The second crop is borne on the current season's growth and is the main crop. In North India, the spring crop ripening in May is taken as the main crop. In Central and South India, the fig bears in July to September and February to May. The latter crop is sweeter and more valuable. The yield per tree is only about 300 fruits in India. In Mysore, only 180 fruits per tree are borne by the small bushes.

The common cultivated figs, which have lobed leaves, have not been found successful in India. The Indian varieties have unlobed or faintly-lobed leaves. These are probably hybrids between the common fig and the Indian wild species, which have unlobed leaves. The Indian species, mentioned earlier, are nematode-resistant. They have probably imparted this character to their cultivated offsprings. The foreign varieties have failed to be successful in India due to their inability to stand the presence of nematodes in the soil. The Poona fig is bell-shaped, light purple, with rosy flesh. The variety Marseilles grows well at higher elevations, has pale-green fruits and sweet, whitish flesh. In U.P. the most successful variety is Black Ischia. This variety differs from the true variety of this name. It is, therefore, a misnomer.

The most serious disease of fig in the Poona area is the rust caused by the fungus *Cerotelium fici*. Small rusty spots appear on the lower surface of the leaf. It defoliates the tree and the fruits drop off. Spraying with 5:5:50 Bordeaux mixture checks the disease, but cannot cure it. Another fungus attacking fig leaves in U.P. is *Cylindrocladium scoparium*. *Cephalosporium fici* has also been reported. The insect pests found on fig in India are the stem-borer (*Batocera rufomaculata*), the leaf-eating caterpillar (*Ocinara varians*), mites of various types, the oriental yellow scale (*Anonidiella orientalis*) and the caterpillar, *Phycodes minor*.

PHALSA

Phalsa or falsa, *Grewia subinaequalis* (*G. asiatica*) is native to India in the Baroda area. It belongs to the botanical family Tiliaceae, to which also belongs jute, our major money-crop. A wild species *Grewia elastica* (*G. asiatica* var. *vestita*) grows on lower hills all over India. Phalsa is a small bush, which bears many small berry-like fruits. This sub-tropical fruit comes to the market in May-June. A cold drink prepared from its juice is a delicacy in scorching weather. It is one of the most hardy fruits, is drought-resistant and requires little care. It is also grown as a filler tree

among mangoes, etc. Its popularity is restricted by the fact that the fruit is very perishable and the tiny fruits have to be picked from a bush several times during the fruiting season. This adds to its cost considerably.

Phalsa is grown mostly from seed, but propagation from cuttings with the use of plant hormones (growth regulators) is also possible. Generally, the bushes are planted three metres apart. The most important operation in the cultivation of phalsa is the pruning. In North India the plants begin to shed their leaves slowly after the middle of winter. They should be pruned at this stage. They start growing soon after pruning. The plants should be cut off about one metre above ground. Cutting closer to the ground or leaving longer shoots decreases the yield. In South India, the plants are allowed to grow much taller and little pruning is done. The trees are also spaced wider apart.

The plants start bearing in a year or two. The yield per bush ranges from 5 to 10 kg. The bark-eating caterpillar and sometimes the mealy bug, when the phalsa is inter-planted with mango, are the pests found in India. A leaf spot disease caused by the fungus *Cercospora grewiae* is also found.

DATE-PALM

The date (*Phoenix dactylifera*) is one of the oldest fruits and was known to man many thousand years before Christ. It originated in the Mesopotamian basin in Arabia where the culture of mankind originated. The date-palm is a monocotyledonous plant like the banana. Therefore, its stem is unbranched and it does not grow in thickness with age. Dried dates are one of the most nourishing foods in the world. They contain about 70 per cent sugars, 2 per cent protein, 2.5 per cent fats and some minerals.

It is the staple food of the Arabs. Large quantities of dates are imported by India from the Arabian countries. Wild date-palms are seen growing even up to an altitude of 1500 metres. Of course, they do not fruit at this altitude every year. A species, *Phoenix sylvestris*, with inferior, but edible fruits is native to India and large clusters of these palms are found naturally occurring along streams, etc., all over the country. A raw sugar and a fermented drink "toddy" are prepared from the sap of this palm. The cultivated date-palm is believed to have originated from this species. It is curious that in spite of all this, dates are not cultivated commercially in India. The reason for this is that it ripens in India in July when the monsoon rains have started. The fruits, therefore, rot.

The date-palm is a fruit of the deserts of the Middle East. It is said that it likes to have its head in fire and its feet in water. This is undoubtedly an overstatement. However, it needs a great deal of heat for ripening the fruit and also needs irrigation. It is very deep-rooted and can draw moisture from great depths of the sub-soil.

An interesting thing about the date-palm is that there are male palms and female palms. A 10 per cent population of males is necessary for good fruiting. The Arabs often insert a few strands of flowers from the male trees into the female flowering clusters. The palms for planting have to be of a known sex and are propagated by removing the suckers (off-shoots) along with their roots from the base of the mother-palms.

Several varieties have been tried in India. Only early varieties with a moderate heat requirement have been found successful. These include Hillawi, Khudrawi and Zahidi. The yield from a good palm should be 50 kg. from about 10 bunches.

MINOR SUB-TROPICAL FRUITS

The Indian gooseberry, 'aonla' or 'nelli' is sometimes called myrobalan, a name also used for some other fruits. Botanically, it is called *Phyllanthus emblica* or *Emblica officinalis* and it belongs to the family Euphorbiaceae. Its small leaves are clustered on their branchlets in such a way that each branchlet appears to be a compound leaf. Male and female flowers appear on these branchlets late in spring, when hot winds blow in North India and fruit-set is often a problem. Sometimes the trees set no fruit for many years. Some trees continue to bear a scanty crop throughout their life.

The aonla fruit is one of the richest sources of vitamin C. It contains 500 to 750 mg of ascorbic acid per 100 g of pulp. This is much more than the vitamin C content of guava, tomato or citrus fruits. Only the Barbados Cherry (*Malpighia glabra*) exceeds this figure. The small, round six-lobed fruits with hard pulp are astringent and not fit for eating fresh. They are extensively used for making pickles and preserves. The astringency helps preserve vitamin C in the ripe fruit, but even then most of it is lost in the process of pickling. When the fruit is treated with a 2 per cent salt solution, most of the astringency is lost, but the major part of vitamin C is also destroyed. If the fruit is put into boiling water for a few minutes before treating with the salt solution, a much greater quantity of vitamin C is retained.

Aonla is grown as a commercial crop primarily in U.P. It also grows wild at the foot of the Himalayas and at elevations up to 1500 metres in South India. A type called Banarasi aonla, with the fruit having a diametre of about 5 cm. is gaining popularity.

Aonla is successfully propagated by budding in the month of June. Inarching gives weak plants with poor survival. In North India, the fruit ripens in winter. In South India, the main flowering takes place in July and again in February. The yield of the tree is very variable. The cultivation of large-fruited types, which bear a crop regularly every year, is very profitable. The star gooseberry or Otaheite gooseberry is a related species, *P. acidus*. The fruit is more ridged. It produces two crops, one at the end of the rainy season and the other in April-May. In South India, it bears almost throughout the year, the crop being most abundant in January-February.

The aonla is sometimes confused with the olive (*Olea europaea*). The latter is a better fruit, used for pickling and for extraction of an edible oil. It is a tree of the Mediterranean area, and requires a dry climate and winter chilling for flower-bud differentiation. A few olive trees may be found growing in places like Bilaspur in Himachal Pradesh, but it has not been found successful in India so far.

Mulberry is a common tree found all over India. It grows in temperate, sub-tropical and tropical regions. Some of its species grow wild in the Himalayas and others in the submontane areas. It is grown principally to rear silk worms on its leaves in Kashmir and Mysore States. In South India, the area under mulberry for this purpose is over 40,000 ha. The species grown for this purpose is the Chinese species *Morus alba*, belonging to the family Moraceae to which also belong the fig and the jack-fruit. The fruit of this species is white or light pink and not of a good quality. The species grown for fruit is *Morus nigra* or the black mulberry. It is less cold-hardy, but the quality of fruit is better if the winter season is somewhat cool. The mulberry fruit is highly perishable and is not commercially important. The fruit ripens in April-May. A properly-pruned and manured tree can give a yield of 20 to 40 kg every year. The propagation of mulberry from cuttings is easy. In winter whole trees can be transplanted after cutting off all the branches and most of the roots. They strike root easily in spring.

The bael (*Aegle marmelos*) belongs to the family Rutaceae, to which also belong oranges and lemons. The structure of the fruits of these two types is, however, very different. The bael fruit has a hard shell and the pulp contains tunnels which are filled with a mucilage. It is indigenous to India and grows wild all over India. It is often planted in gardens, but no regular plantation of bael exists. The bael is considered to have many medicinal properties and is effective in the treatment of dysentery. It also makes an excellent squash.

It can stand swampy or alkaline soils and is propagated usually by seeds, which are sown in June. Budding in the same month is also very successful. Root cuttings and layers are also successful. The yield per tree is 300 to 400 fruits every year.

A similar hard fruit is the wood apple (*Feronia limonia*). It belongs to the same family. The tree is larger and the surface of fruits and branches is very rough and covered with a white bloom. It is indigenous to India.

The karonda, *Carissa carandas*, belonging to the family Apocynaceae, is a hardy shrub, which is indigenous to India and is grown commonly as a thorny hedge plant. It bears a profusion of berries, which make an excellent pickle and jelly. There are two types of fruit. One has a whitish fruit with pink blush. The other has dark purple fruit. It is grown commonly from seed. The seedlings are transplanted when two years old. The fruits ripen from the beginning of the rainy season till October in North India. One would hardly expect any disease or pest on this thorny hedge plant, but it does suffer badly from anthracnose caused by *Colletotrichum inamadarii* in U.P. The disease enters the leaves, where they have been punctured by its own thorns. Two other species with edible fruits, *C. pancinervia* and *C. spinarum*, are found in South India. *C. congestata* is also found wild in India.

An African species, *C. grandiflora*, called Natal plum or African carissa, is also grown in India. The bush is smaller, but its thorns are prominent and bifurcated and the leaves large, thick and dark green. The flowers are also larger, fragrant and appear several times a year. The fruit is large and dark red.

The "Jaman" or Java plum, *Syzygium cuminii* (*Eugenia jambolana*), is considered to be native to India or further east. It belongs to the family Myrtaceae to which also belongs the guava. It is a common tree all over India, wherever the mango is found. It is not grown in regular plantations but is a common roadside tree. A related wild species, *S. fruticosum*, with small, but edible fruits is grown as a wind-break around orchards. The large evergreen tree has small dark purple date-like fruits with prominent elongated seeds. The colour of the flesh is also purple and the fruit is astringent even when ripe. Some superior types have large fruits with whitish flesh. Its fruits ripen a little later in the season than mango. It is usually propagated from seed. The fruit is usually shaken with salt before eating. Two insect pests, the leaf-eating caterpillar (*Carea subtilis*) in South India and a whitefly (*Dialcurodes eugenia*) in all parts of India are commonly found.

A similar fruit, which is more tropical, is the rose apple or gulab jaman (*S. jambos*). It is found in South India up to elevations of 1,200 metres. It grows in both dry and humid areas. Its leaves are larger and the tree is very ornamental. The fruit is the size of a golf ball and greenish yellow in colour. The flesh is spongy and aromatic. The fruit does not have any commercial value, but can be used for candying, etc. Another similar species, *S. javanica*, bears fruits profusely. It is propagated from seed, but layering is also possible. Other species of *Syzygium* found in India are *S. kurzii*, *S. formosa* found in the Eastern Himalayas, *S. zeylanica*, a small tree with edible fruits, found on the Western Ghats of India, and *S. malaccensis*, a few trees of which are found in South India. Another related fruit found in South India is the Surinam cherry, Brazil cherry or the pitanga (*Eugenia uniflora*). It is a small tree with bright red angular fruits less than an inch in diametre, having an armoatic flavour. It is encountered in South India at elevations from 500 to 1,500 metres and can also grow in North India. The clove, *Syzygium aromaticum*, is also closely related to the above plants.

A fruit growing wild in Bengal is the "baichi" belonging to the family Flacourtiaceae. Two species are included under this. The common one is *Flacourtia jangomas*, which is considered a native of India. It is sometimes called paniala, but this name is confusing since it is also used for a Malayan species, *F. inermis*, which is also called lovi-lovi or tomi-tomi. The other species is *F. indica* and is called ramontchi, Governor's plum or Madagascar plum and is ornamental. They are medium-sized, spreading and thorny trees. The fruit quality shows great variation since they bear male and female flowers on separate trees. The fruits are red to dark purple and 1½ cm. to 2½ cm. in diameter. Vegetative propagation of trees with sweet fruits has been recommended. Inarching, budding, layering and cuttings are successful. Some pruning of the trees and irrigation are said to be desirable.

Avocado is a fruit native to tropical America and is said to have been introduced into India in the beginning of the 9th century. Several varieties of it grow successfully in Bangalore and at Kallar and Burliar at the foot of the Nilgiri Hills. But it has not gained any popularity in this country. It is an unusual fruit rich in fats and proteins, but has practically no taste. In tropical America, it is a staple food. It has also become very popular in the U.S.A. on account of its nutritive value. The fruit has not gained popularity in India due to lack of sweetness and character.

There are two species of this fruit belonging to the laurel family (Lauraceae). The West Indian and Guatemalan races belong to the species *Persea americana* and the small-fruited Mexican race to the species *P. drymifolia*. Avocado is tender to frost and also cannot stand the hot dry winds of North India or makes poor growth. The West Indian race is successful in South India, especially where the rainfall ranges between 75 cm and 180 cm.

The fruit of the avocado is a somewhat pear-shaped berry of the size of a large pear to a small grape-fruit. It has a single large seed surrounded by buttery pulp and a hard skin. It can be propagated by layering, shield-budding, Forkert-budding or side-grafting. The layered-plants are ready in six months and make good growth when planted in the field after another six months. The avocado tree attains a large size and should be planted 8 to 10 metres apart. Hardly any pruning is required for this evergreen tree. The trees start bearing at the age of five years and the yield in India is 100 to 200 fruits per tree. The fruits mature in May-June and August-September. The problems of avocado cultivation are frost injury, poor fruit-set, alternate bearing and foot-rot of the trees. In view of its high nutritive value, it would be worthwhile to popularise it in India.

The passion fruit is a sub-tropical fruit, which thrives in South India. The plant derives its name from the way the perennial vines cling to the supports and not from any aphrodisiac property of the fruit. It has ornamental flowers with a prominent corona or crown. The fruit is the size of a sapota and has a hard shell. It contains numerous seeds covered with juicy arils. The seeds are attached to the outer wall of the fruit, as is the case with papaya. The juicy covering of the seeds constitutes the edible part. The juice is sweet, but has over three per cent acid content. It is, therefore, not a table fruit, but makes an excellent squash. It is rich in vitamins C and A.

There are two important types of passion fruit. The yellow-fruited kind, *Passiflora edulis* var. *flavicarpa*, is more tropical and grows on the plains and low hills in South India. It has a very good flavour. It should be propagated by stem cuttings, but can also be grown from seed. The plants are set three to four metres apart and are trained along a three-wire trellis. It is a hardy plant and requires little manuring or irrigation. In South India, no pruning is generally done, but pruning of the hanging tertiary branches to two nodes gives a good yield. Bearing starts after a year. A yield of up to 12 tons per hectare is obtained.

The other kind is the purple passion fruit, *Passiflora edulis*, cultivated at altitudes of 1,000 to 2,000 metres in South India. It requires a cooler climate, but is easily damaged by frost. Its fruit quality is inferior and it starts bearing after two years. Its fruits ripen in May-June and in September-October. Another type, the giant granadilla (*P. quadrangularis*), has a very large, four-sided, elongated fruit. It grows on the lower elevations of the Nilgiris, but has an inferior quality and is not commercially important. Passion fruit is not commercially cultivated in North India due to damage from frost.

The capegooseberry, *Physalis peruviana*, is an annual herbaceous plant belonging to the family Solanaceae, to which belong tomato and brinjal. The small seedy berries are enclosed in a papery husk constituted by the calyx of the flowers. It is a good fresh fruit and also makes an excellent jam. It should not be confused with the gooseberry, a temperate bush-fruit belonging to the genus *Ribes* of the family Rosaceae.

As is the case with all members of this family, the plants are very sensitive to frost injury. In U.P., where it is cultivated commercially, the seeds are sown in the hot weather from May to July and the transplanting is done when the seedlings are less than 25 cm. high. The fruit is harvested in February-March or even earlier. A late crop is likely to be damaged by frost. The plants are set on ridges half to one metre apart. The soil should be well drained and 20 tons of farmyard manure is added per hectare. The yield varies from 13 to 22 tons per hectare. In the Punjab, later planting has been suggested, but the fruit-size and yield are small, since the crop ripens in warm weather. In the hot weather, it requires very frequent irrigation. The crop is often affected by the leaf-curl caused by a virus.

In South India, cape gooseberry is planted at altitudes of up to 1,500 metres in the Nilgiri Hills and the Araku valley in Andhra Pradesh. The plantation is kept for two to four years and propagation can be done by layering. The plants are set out in July 60 to 80 cm. apart. The crop ripens in February to April and a yield of 25 tons per hectare can be obtained.

Another species with bigger tomato-shaped firm fruits is *P. ixocarpa*. It is called tomatillo. Its fruits are not juicy or sweet enough. It can be used only for making a chutney. It can be sown and made to flower almost any time of the year.

The tree tomato, *Cyphomandra betacea*, belongs to the family Solanaceae. It grows at elevations of 1,000 to 2,000 metres in South India and also in Assam. It is a large bush, which bears tart fruits looking like a 5-cm. long oval brinjal. The fruit is added to curries. The common type has yellow or tomato-coloured fruits. Another type has dark purple fruits and is liked better. It is found in gardens and is not grown commercially.

It is propagated from seed. In South India it can also be propagated from hardwood cuttings in November. The plants start bearing in two years and give a yield of about 20 kg. every year. They bear fruit for 10 years.

CHAPTER X

TEMPERATE FRUITS

THERE ARE many important fruits grown in temperate climates. All of these belong to the family Rosaceae, except nut crops like walnut, which belongs to the family Juglandaceae. Apple is by far the most important fruit in this group. It is the leading table fruit of the world, since it has an attractive appearance, is easy to cut and handle at the table, is not exacting in its climatic and manurial requirements and can be stored at ordinary temperatures for weeks or even months.

In India, the temperate fruits are confined mostly to the Western Himalayan region. A very small area is found in the Nilgiri Hills. Many species of these fruits are found growing wild in these regions. Wild crab apple, wild peach (Artoo), wild apricot (Chool or Zardalu), wild pomegranate (Daru), the seeds of which are used as a condiment, some brambles (*Rubus ellipticus* called Heer or Hinsar), wild strawberry (*Fragaria nilgerrensis*), found in the Nilgiri Hills, *F. indica* and a large fruited type called Bhumla found at elevations of about 9000 feet, Kafal or cowphal (*Grewia cawa*), wild pears locally called Shiara (*Pyrus pyrifolia*) and Kainth (*P. pashia*) and many others are found growing at various altitudes. The wild pear (*P. khasiana*) found in the Eastern Himalayas very closely resembles the species *P. pashia* of the Western Himalayas. The Himalayan wild cherry called Paja (*Prunus puddum*), which is an evergreen tree, is laden with a mass of pinkish white flowers in October and lends great charm to the Himalayan landscape at this time of year. It is different from the deciduous species *P. padus*, which flowers in spring.

In spite of the profusion of the wild species of temperate fruits found in India, their commercial cultivation in India is extremely limited. India produces about 0.6 per cent of the total world production of 21 million metric tons of temperate fruits per annum. These fruits constitute only 2.5 per cent of the area under fruits

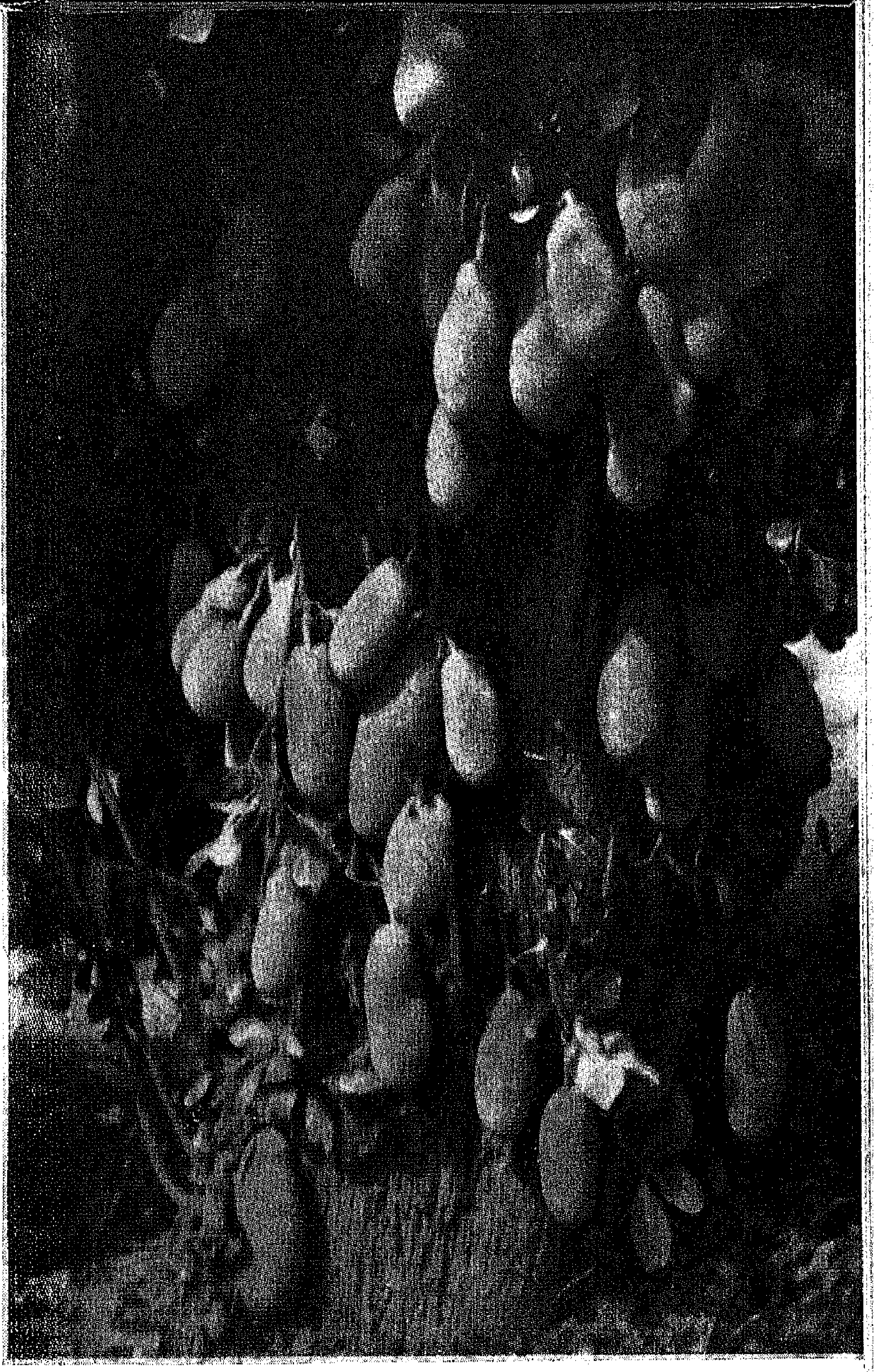


Plate V. JACK FRUIT (*Artocarpus heterophyllus*)
(*page 115*)

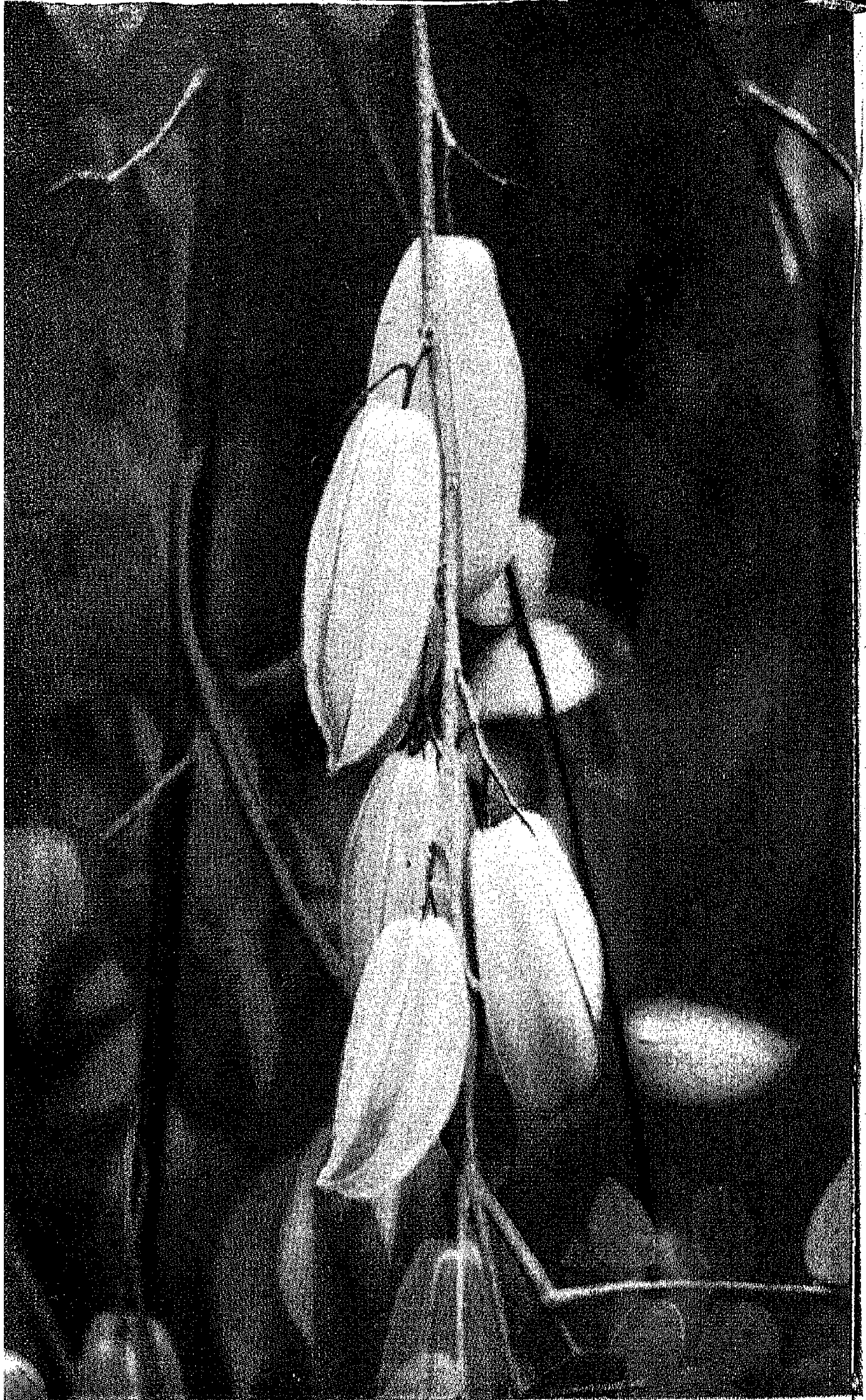


Plate VI. CARAMBOLA (*Averrhoa carambola*)
(*page 126*)

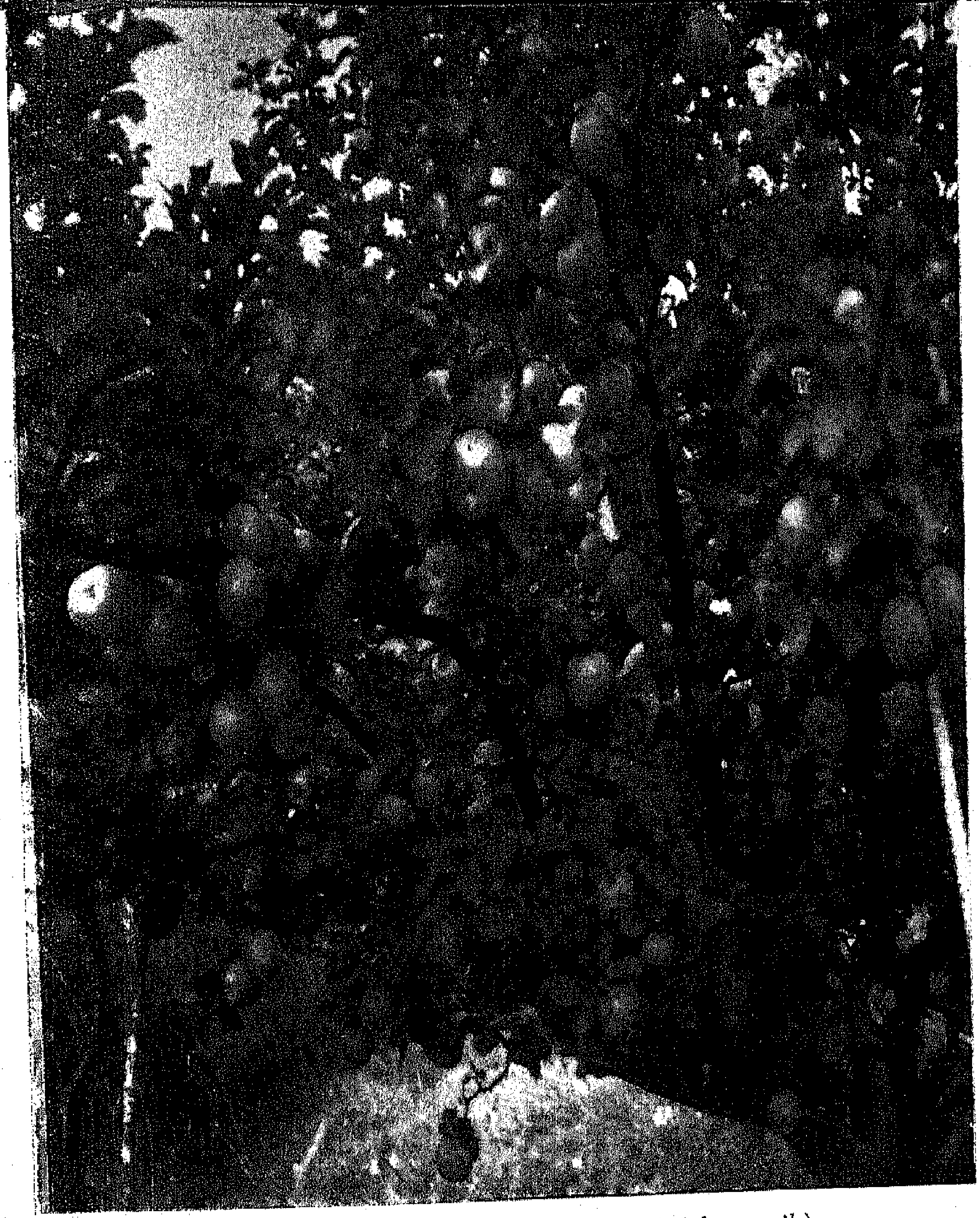


Plate VII. A BEARING TREE OF APPLE (*Malus pumila*)
(*page 157*)

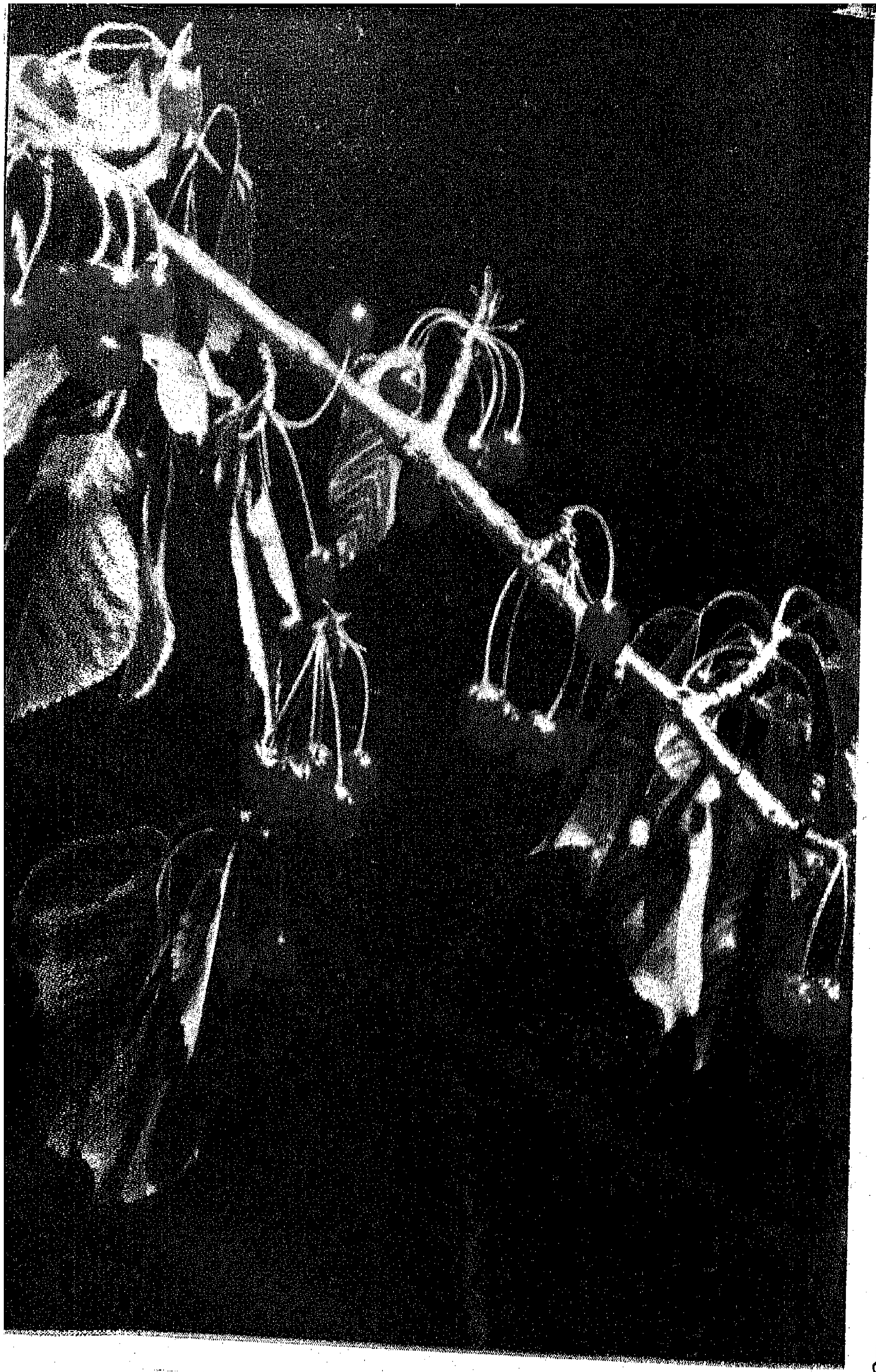


Plate VIII. SWEET CHERRY (*Prunus avium*)
(*page 165*)

in India (about 17,000 hectares). About two-thirds of this area is under apple. Jammu and Kashmir is the leading State with an area of about 13,000 ha. Himachal Pradesh has an area of about 4,000 ha and the Kumaon Hills in U.P. about 2,500 ha. Assam and the Nilgiri Hills have an area of about 150 ha each. These fruits can be grown only in places where the winter is distinctly cold. Without exposure to a specific minimum chilling in winter, the trees do not flower properly in spring. This is the reason for the lack of success of these fruits in places like Pachmarhi (altitude 1,100 metres) and Chhindwara (altitude 700 metres) in Madhya Pradesh. The cultivation of these fruits in the Eastern Himalayas is restricted due to heavy rain and high humidity which encourage the incidence of diseases and cracking of fruits like cherries, plums, peaches and almonds in the early rains. Cultivation of temperate fruits is, therefore, confined mostly to the Western Himalayas. Here also every place is not suitable. Localities with frequent hail-storms, which cause shedding of leaves, flowers and fruits or spoil the appearance of fruit, and spring frosts, which damage the flowers, are not suitable for fruit cultivation. Sites with poor air drainage also cause damage from cold and are unsuitable. Suitable areas for the cultivation of temperate fruits are, therefore, limited.

Another factor hindering the expansion of the area under these fruits has been the lack of proper transport facilities in these mountainous areas. In the past fruits have often rotted during the rains on account of blockage of roads due to land-slides, in places like Kulu and Kotgarh in Himachal Pradesh. The situation is now improving.

The climatic requirements of the different temperate fruits vary greatly. Apple, cherry and walnut require the coldest climate and are generally cultivated from an elevation of 1,600 metres to 2,700 metres. Pear and European plum thrive at elevations of 1,300 to 2,000 metres. Peach, Japanese plum, apricot, almond, persimmon and strawberry thrive at elevations of 1,000 to 1,600 metres. Some peach and plum varieties grow successfully even in the submontane areas.

Commercial cultivation of these fruits in India is of recent origin.

All commercial varieties have been introduced from abroad. The variety Ambri of Kashmir is considered to be indigenous to India by some people, but this also seems to be an introduction from Central Asia. Commercial cultivation was started by European settlers and missionaries after 1870. Captain Lee started orcharding in the Kulu Valley and Coutts in the Simla area. S.C. Stokes started an orchard in Kotgarh in 1917-18. Kashmir was the first State to visualise the great potentiality of fruit-growing in the temperate zone. Its energetic Director of Agriculture from 1910 to 1920, Mr. M. Pychard, who was a Frenchman, introduced many varieties from his native land. Incidentally, Kashmir was also responsible for introducing the San Jose scale into India. This insect pest was introduced from France in 1906. It almost wiped out the cultivation of apple and other temperate fruits in this State. The State gave free plants to growers in the beginning. In 1946 it charged only one anna (1/16th of a rupee) per plant and in 1947 the price was raised to the still nominal level of 4 annas per plant. The Kulu Valley specialised in a trade of sending apples by parcel post to far-away places in boxes of 10 lb. In 1945 about fourteen thousand such boxes were estimated to have been despatched. Even today parcels are sent to distant places like Nepal. At Kandaghat (now in Himachal Pradesh), the Maharaja of Patiala started the cultivation of peaches, plums, etc., under the advice of an American expert, Dr. R.W. Hodgson.

In the recent past, fruit-growing has expanded rapidly in Himachal Pradesh, but it has received a set-back in Kashmir due to the attack of San Jose scale and some diseases. A few apple trees used to be grown near Bangalore in South India at an altitude of 1,000 metres. These have also received a severe set-back due to serious attack of the woolly aphis.

Except for the State of Kashmir, where the majority of orchardists are small farmers, the cultivation of apple has been done in India as a methodical industry. This is due to the good example of the pioneers in the field who were well-educated people and the fact that apple cultivation gave very high returns. As a result of this, the price of land in areas suitable for this purpose has gone up to Rs. 25,000 per hectare.

The site for fruit cultivation in the hilly areas should have a good air drainage and be free from frost pockets. The soil should be fairly well-drained, medium loam. Apple requires a loamy soil at least 1.25 metres deep with sufficient organic matter in the top 0.5-metre layer. The presence of lime in the soil is good for apple cultivation. Pears do better on well-drained heavy soils and are less tolerant to drought. Plums have the same soil requirement as pear, but can grow on much poorer soils, if plenty of farmyard manure is supplied. The pH of the soil should be about 6.0 or 5.5.

Most of the temperate fruits in India are grown on hill-slopes except in the Kashmir valley and a limited area in the Kulu Valley. On the hill-slopes the planting is done on narrow terraces running along the slopes. The rows of trees run along the hill and not up and down the hill. Erosion of land is a great problem under these conditions. Clean cultivation is,therefore, not desirable. Combination of cover cropping and sod culture is desirable. Unlike other fruit crops like citrus, apple can grow successfully under sod, provided additional nitrogen required for the growth of the grass is provided. It would be desirable to cut the grass after the rainy season and to spread it under the trees. It would add organic matter to the soil and also act as a mulch. Unfortunately, there is great shortage of fodder in the hills and the general practice in these areas is to cut the grass and remove it for feeding cattle. The basins of the trees are kept free from weeds by four or five hoeings per year.

In most of the areas, irrigation is not available except in Kulu and parts of the Kashmir valley. These fruits can be grown successfully without artificial irrigation, provided the natural precipitation is not less than 50 cm per annum. Snow in winter also adds to soil moisture. Under these conditions, the trees are hand-watered during the first two or three summers. However, irrigation during the fruiting season improves the size of the fruit in plums and peaches. Mulching of the soil under young trees conserves moisture.

When one sees apple trees laden with fruit growing in the scanty soil between big rocks, one wonders from where the tree gets the nutrients to raise the beautiful fruits. Apple and pear require very little manuring as compared to fruits like citrus. They can also draw nitrogen from the soil, even when it is present in very small proportions. However, some temperate fruits like the peach require higher amounts of nitrogen. According to one recommendation, the temperate fruits are given 4 oz of ammonium sulphate, 4 oz. of superphosphate and about 3 oz. of sulphate of potash for each year of the age of the tree. For a full-grown apple tree, the maximum dose is ammonium sulphate 5 lb, superphosphate 5 lb, and sulphate of potash 3 lb.

The temperate fruits are easy to propagate. The usual methods are tongue-grafting or wedge-grafting in January-February or shield-budding in summer. In apple ring-budding is also practised in summer. The trees can be transplanted with bare roots late in autumn. They make good growth in the following spring. Transplanting can also be done in spring.

In Kashmir and the Kumaon Hills, the trees used to be trained in the past in the open centre or vase form, with the lowest branch arising four feet above ground level. This method is useful for European countries with poor sunlight, but it is now realised that under Indian conditions the modified leader system is more suitable. It prevents the breakage of limbs encountered in the former method.

APPLE

Apple is undoubtedly the most important temperate fruit. It excels the pear in its excellent keeping quality and wide variety of tastes and flavour. It is the premier table fruit of the world and has been under cultivation since time immemorial. The cultivated apples belong to the species *Malus pumila* or *Malus sylvestris*. It originated in South-West Asia.

In India, apple cultivation is extremely profitable, as is the

case with grape-growing in the Hyderabad area and South India. In Kotgarh, a yield of up to 500 kg per tree has been reported. However, assuming an average yield of one-fourth of this quantity and an average number of 50 trees per acre, a gross income of Rs. 15,000 to Rs. 20,000 is assured. Consequently, apple cultivation has become the major industry of Himachal Pradesh.

Apple requires chilling below 40°F for a period of two or three months. Therefore, it is generally grown at elevations from 1,600 to 2,300 metres in India. Its cultivation in the Nilgiri Hills is not quite successful for want of enough chilling. In the Kulu Valley, which being situated deeper in the Himalayan ranges, is cooler, apples are grown at elevations as low as 1200 metres. However, when the temperature falls below 28°F, apple trees are injured by the cold. Several commercial varieties of apple, especially triploids like Baldwin, are self-unfruitful and require cross pollination.

Apple is generally propagated by budding or grafting on seedlings of crab apple, Golden Delicious, or Rus Pippin (Yellow Newton). The Red Delicious has a few seeds in each fruit but they germinate and grow well. Shield-budding with buds of current season's growth is done in the month of June. Grafting is done at the end of winter. Several Malling root-stocks developed in England are vegetatively propagated. They can be used to control the vigour of the plants. Seedlings as well as grafted plants of apple can be lifted in winter with bare roots.

The planting distance in India varies from 7 to 10 metres, depending upon the vigour of the plant. Generally, there is a tendency to plant the trees closer than is necessary. Planting is done late in winter after the danger of frost is over.

The pruning and training of apple are important. In India the trees should be trained by the modified leader system with three to five main branches and a clean trunk of about one to 1.5 metres. One-year-old plants are planted in late winter and are cut back at about 80 to 100 cm above ground. If branches are present at this time, only four to five of them ought to be retained and shortened in length. No shoot is retained below 50 cm from ground. At the time of first dormant pruning the main scaffold branches are cut back to about half a metre in length. Secondary branches arise from these main limbs. Some of the new shoots arising early in the second summer are rubbed off in order to develop only a few vigorous secondary branches. During the second dormant pruning, the crowded, misplaced or diseased secondary branches are removed and the extra-vigorous ones headed back. This process is continued for four or five years, at the end of which there are eight to ten scaffold branches.

The pruning of bearing trees is important to maintain a balance between vegetative growth and fruit-production. Too much vegetative growth results in poor fruiting and the absence of vegetative growth reduces the crop in the subsequent year. With proper pruning, the branches of a young tree should make an extension growth of about 25 to 50 cm every year. Older trees should make half this extension growth. Some apple varieties bear fruit on short crooked growths called spurs. The spurs bear fruit for several years. Such varieties require little pruning. Varieties bearing fruit on young shoots require more pruning to encourage new growth of branches. Older trees require more pruning than young ones. Thinning of the fruit is also practised in order to improve fruit colour and fruit size. It is desirable to leave about one fruit for every 40 leaves. This spaces the fruits about 15 to 20 cm apart and there is only one fruit per spur. Apple trees do not require heavy fertilization. Generally, 30 grams of nitrogen for every year of the age of the tree is required. Similar quantities of phosphate and potash should be added when required. However, in the Kumaon area, the application of nitrogen and potash does not seem to improve the performance of the trees. For distant markets the fruit is harvested in advance of full maturity. Harvesting is in full swing in September-October except in the Nilgiris, where the season is from April to July. The harvesting of different varieties starts from June and continues up to November. Each tree is harvested in three instalments. The harvested fruit can be stored for about three to four months at room temperature in a temperate climate. In cold storage at temperatures of 0° to 1.6°C varieties like Ambri and Red Delicious can be stored up to eight months. Early varieties have a shorter storage life. A full bearing tree yields from 40 to 100 kg of fruit. In the Nilgiris, the yield is only 10 to 20 kg per tree. The bearing generally commences after five years and continues for about fifty years. Several varieties show alternate bearing.

There are numerous varieties of apple, but in India only a few are commercially important. The variety Ambri used to be most extensively grown in Kashmir. Its fruit is ovate-oblong with prominent red stripes. It is a regular bearing variety with a high yield. The fruit is sweet with firm flesh and exceedingly good transport quality. It has an attractive aroma and practically no acidity. By western standards, the fruit quality lacks acidity.

The fruit of the variety Red Delicious tapers towards the basin with five prominent ribs. It has an excellent fruit quality, is regular and heavy-bearing and is a mid-season variety. It is grown widely in Himachal Pradesh, Kumaon Hills, Kulu and since recently in Kashmir. The fruit of this variety loses its quality when even slightly over- ripe and has a poor storage life. It is good for cultivation at high altitudes. Another variety with similar fruit, but with a deeper red colour, is the Royal Delicious or Starking Delicious, which is beginning to replace the Red Delicious.

Golden Delicious is a yellow apple with excellent fruit quality as well as keeping quality. It is also a good polliniser for many varieties. It is somewhat regular-bearing. Its seeds are often used for raising root-stock.

Other important varieties in India are Rymer, Versifield (Maharaji), Winter Banana, Baldwin, Cox's Orange Pippin, Early Shanbury, Imperial, Jonathan, Granny Smith and Irish Peach (also grown in South India). Some new varieties being tried include Richard and Red June. Low chilling varieties like Tropical Beauty from Australia, Beverley Hills from California and some varieties from Israel are of interest for cultivation in warmer places.

Under the Agmark scheme of the Marketing Department of the Government of India, apples are graded according to size, besides considerations of colour and freedom from blemishes. The various grades according to diameter of fruit are super (3″), fancy ($2\frac{3}{4}$″), selected ($2\frac{1}{2}$″) and commercial ($2\frac{1}{4}$″).

In a small area around Bangalore in South India, apple cultivation of a specialised type has been practised. In this semi-tropical climate, the trees remain very short, are planted 4 to 5 metres apart and produce not more than 50 fruits per tree. However, in this equable climate, there are two crops a year. Since there is no winter chilling, root-pruning is done twice a year, in August-September and in January-February, to provide artificial rest to the trees and force them to flower. All leaves not shed after root-pruning are clipped off. Rome Beauty is the variety cultivated here. It is grafted on Northern Spy root-stock, which is resistant to the woolly aphis. The consumption of this fruit was localised to the markets in Bangalore and Madras. This industry has been on decline due to the attack of woolly aphis and greater availability of apples grown in North India.

PEAR

Pears are the only temperate fruit grown to any extent on the hills in South India. Kashmir has the largest area. Some wild pear trees have been top-worked with the Bartlett variety in Kulu. Pears are cultivated at lower altitudes than apples. Their perishability is responsible for their limited cultivation.

The pear is similar to the apple in its cultivation requirements. The fruit is generally pyriform but round-fruited varieties are also found. The common cultivated pear (French pear), *Pyrus communis*, is highly susceptible to the fire blight disease. The oriental pear, *Pyrus pyrifolia*, and allied species are resistant to this disease. Most of the varieties are self-unfruitful and require pollinisers. The most important varieties of Kashmir are Bagu Gosha (Bartlett or Williams Bon Chritien) and Gosh Baghu (Citron-des-Carmes). The latter is a late variety with a better keeping quality. The former is good for canning. Other important varieties are Conference and Winter Nelis. Kieffer is cultivated in the Kodaikanal area in South India. It is a cross between the French pear and the oriental pear. A hardy type called Nashpati is cultivated in the submontane areas of the Punjab and U.P. It bears a heavy crop of poor quality fruit and does not require cross-pollination. Some small fruited varieties like the China in Himachal Pradesh and Chusni (Thumb pear) in the Kumaon Hills come to the market as early as June. Beaurre Hardy and Louis Bon Jersey are good quality varieties grown above 1,700 metres in South India.

The root-stocks generally used for pear are the wild Himalayan pears, *Pyrus pashia*, *P. pyrifolia* and *P. khasiana*. Pear requires a little more nitrogen than apple, but it is generally grown in poor soils. The trees tend to produce many dense upright branches. The main consideration in its pruning and training is to thin out dense central branches and encourage lateral growth.

It has been recommended that old trees should be given $\frac{3}{4}$ oz of ammonium sulphate, 2 oz of superphosphate and $\frac{1}{2}$ oz of potassium sulphate per square yard of the area under the tree in order to encourage vegetative growth and improve fruiting.

The fruit of the pear is highly perishable and is picked when still green and hard. However, late varieties should not be picked too early, otherwise the fruit shrivels and fails to develop proper flavour. It ripens at a higher temperature than apple. It also requires less fruit-thinning than apple. Generally, no thinning is done in India. The bearing life of the trees in India is about 60 years. Flying foxes cause considerable damage to the fruit.

Under the Agmark scheme, the fruit of the Bartlett variety is graded into extra large ($2\frac{3}{4}$″ diameter), large ($2\frac{1}{2}$″), medium ($2\frac{1}{4}$″) and small (2″).

Another pome fruit grown only in Kashmir is the quince (*Cydonia oblonga*). It has an apple-like yellow fruit, which is ribbed and has a hairy surface and many seeds. It is used for medicinal purposes.

DRUPE FRUITS

Whereas in the family Rosaceae the fruits of apple and pear are pomes, those in the genus *Prunus* are drupes. Botanically, it is the same type of fruit as found in mango. These fruits include peach, plum, apricot, cherry and almond.

The peach (*Prunus persica*) requires the warmest climate of all temperate fruits and is generally grown in lower hills except for the varieties belonging to the honey group, which can be grown under sub-tropical conditions. Peach is generally self-fruitful except the variety J.H. Hale, which is male sterile. There are many varieties of peach, but Elberta has the widest climatic adaptability. Other varieties cultivated in India include Alexander, Early Rivers, July Elberta, World's Earliest, Triumph, Duke of York and J.H. Hale.

A honey type of peach called Sharbati does well in the sub-montane areas of U.P. Another variety with flat fruit called Chakli grows on the plains, but its fruit quality is very poor.

Peach is generally propagated by budding on seedlings of peach. This root-stock is suitable for light soils. The seeds of peach are stratified before sowing by keeping them between layers of wet sand at a low temperature. For heavy soils and water-logged conditions, plum is a better root-stock. However, most of the plums are incompatible with peach. The planting distance is generally 6 to 7 metres. Peach responds to frequent cultivation, which should not be too deep. It requires a higher amount of nitrogen than other temperate fruits. Non-bearing trees should be given ½ lb of nitrogen per tree for every year of the age of the tree. The bearing orchard should receive 25 lb each of nitrogen and potash and double this quantity of phosphorus in inorganic form and 5 to 10 tons of farmyard manure per acre.

Peach bears fruit mostly on one-year-old wood and its pruning is important. In the training of a peach tree, three to four main limbs with two secondary branches on each are allowed to develop. The pruning of the bearing trees consists of heading back the one-year-old shoots to two-thirds of their length and thinning out some of these. Some of the older branchlets are headed back every year to prevent the tree from becoming very tall. Heavy pruning causes excessive vegetative growth and poor cropping. Light pruning leads to over-bearing and restricted vegetative growth, resulting in poor crop the following year. Fruit-thinning is done in May and June to improve fruit-size. Peaches are harvested when they are still hard. Their quality improves after harvesting. They can ripen well in storage or in transit. The bearing life of the peach varies from 10 to 20 years in India. The yield per tree is 20 to 40 kg.

Recently, the Himachal Pradesh Government has offered to purchase unlimited quantities of peaches of varieties suitable for canning at a fixed rate directly from the growers. This is bound to give a great impetus to the cultivation of good-quality peaches in this State.

The almond (*Prunus amygdalus*) is the most favourite nut in India and sells at a high price. It is considered to have a medicinal value. It is mostly imported from abroad. It is similar to the peach in many ways, but requires a fairly warm dry weather during ripening of the fruit. This factor limits its cultivation. It is the first to flower in spring and is, therefore, damaged by spring frost. Its cultivation in India is mostly confined to Kashmir. Recently attempts have been made to extend its cultivation to the Lahaul and Kinnaur areas of Himachal Pradesh which border Tibet.

Its cultivation is similar to that of peach. It does well when grafted on almond root-stock. The trees are planted 20 to 25 feet apart, preferably in autumn. It bears mostly on spurs, which live for about five years. Therefore, only a light annual pruning is required. Harvesting is started when the hulls covering the hard shell of the nuts begin to split. The trees reach full bearing by the age of 10 years. The yield is low in India, being 150 to 300 kg of nuts per acre.

Almost all trees grown in India are of a seedling origin. Hence, there are no well-established varieties. Among the recently introduced varieties, Non Pareil, a paper shell type, and I X L which is suitable for the foothills are promising. Almonds have a pollination problem and both of the above varieties are cross-unfruitful. Drake is a good polliniser for these varieties. The seedling plantations, of course, have no pollination problem.

About 40 per cent of the area under plums in India is confined to Kashmir. Two types of plum are cultivated in India. European plums (*Prunus domestica*) are cultivated at higher elevations and the Japanese plums (*Prunus salicina*) at lower elevations and in the submontane areas. Most of the European plums are self-fruitful, whereas the Japanese plums often require cross-pollination. The choice of varieties for planting should be made by keeping this fact in view. However, the important Japanese varieties, Santa Rosa and Beauty, are self-fruitful, and can be planted alone. There are several varieties of plum. The important amongst them are Santa Rosa, Grand Duke, Beauty, Plum Red, Mariposa, Kelsey, Wickson, Burbank and Victoria. The prolific-bearing varieties of poor quality grown in the plains are Alucha Yellow, Alucha Red and Titron. Plum is generally propagated by shield-budding on seedlings of wild apricot (Zardalu) or on peach. On heavy sticky soils, plum root-stock is used. The cultural practices are similar to those for peach. Plum requires plenty of irrigation during the fruiting season. The bearing habit of the plum is variable. Several varieties of European plum bear on spurs and require practically no pruning. The Japanese varieties bear a profuse crop on shoots and require more severe pruning. Pruning should be regulated in such a way that the tree makes 30 to 50 cm of extension growth every year. The Japanese varieties require more fruit-thinning than do the European ones. The variety Beauty requires most severe thinning and Santa Rosa only light thinning. Fruit-thinning is done in April and May before the hardening of the pits. Unlike peach, the plums should be harvested when almost ripe to get the best fruit quality. However, for distant markets, the harvesting is done a few days in advance.

Apricot (*Prunus armeniaca*) has a medium to large tree, which is planted 20 to 25 feet apart. Its cultivation is similar to that of plum and peach. The wild Himalayan apricot Zardalu is used

in many ways. The kernel is an important source of cooking oil, the flesh is dried and the leaves provide fodder for sheep and goats. The kernels are also eaten fresh. The oil cake left after the extraction of oil is used as cattle feed. Some varieties of apricot have a bitter kernel, which cannot be eaten, but even from these oil is extracted. This oil can be used for lighting. Dried apricots are an important commercial product, but the drying of commercial varieties is not yet done in India. The important varieties are Kaisha, New Castle, Royal, Moor Park, Shipley Early and St. Ambroise. The propagation is by budding on peach or wild apricot. On heavy soils plum can also be used as root-stock, but the union is not good. Most of the fruit is borne on spurs and a little on one-year-old shoots. Very light pruning is, therefore, required. Fruit thinning is also required. The fruit is harvested when it has attained colour but is still firm. The tree starts bearing at the age of about five years and continues up to about 35 years. The yield is 30 to 50 kg per tree.

Cherry is a perishable fruit. Its cultivation in India is very limited and is confined mostly to Kashmir. There are two types of cherries, the sweet cherry (*Prunus avium*) and the sour cherry (*Prunus cerasus*), which is used for canning or cooking. Theyrequire a climate similar to that for apple. Most commercial varieties of cherry are self-incompatible and some are even cross-incompatible. In establishing a cherry orchard the varieties planted should be able to pollinate one another. Sweet cherry is generally propagated by whip grafting on seedlings of wild cherry called Paja (*Prunus puddum*). The grafts are ready for transplanting within two years. Grafting *in situ* is also practised. Cherry trees are affected by sunscald. They are, therefore, planted on slopes where the sun is not too strong and the trees are kept low headed. The planting distance is 10 to 13 metres. The trees require staking immediately after planting. The cherry orchard can be successfully managed by sod culture. It requires very little pruning. The fruit, which is borne in clusters on long stems should not be harvested when wet. If it rains, when the fruit is ripening, the fruits crack and rot.

The cherry tree starts bearing from the fifth year and reaches full bearing after 10 years. It continues to bear up to the age of 50 years. Fruit-thinning is not practised. The yield is low, being about 10 kg per tree. The fruit is packed in small baskets in Kulu and in wooden boxes containing 10 to 20 lb in Kashmir.

Most of the commercially successful cherry varieties in India have a light colour and firm flesh. These belong to the Bigarreau group, which includes sweet cherries with firm flesh and colourless juice. Early Amber or Pink Early, Frogmore, and Governor Wood are such early varieties. Double Heart, which is probably Napoleon, is important in Kashmir. Senecca is the earliest black cherry of the Heart group and Early Rivers also belongs to the same group.

TEMPERATE-NUTS

After cashewnut and peanuts, walnut (*Juglans regia*, family Juglandaceae) is the next most important nut produced in India. The wood of the tree is used for carvings and for making butts of guns and cabinets of highest quality. The bark is used by women for cleaning their teeth and gums. The walnut is called English or Persian walnut, but is native to the Western Himalayas. It requires a very cool climate and is grown mostly in Kashmir at 1,300 to 2,300 metres like the apple. Most of the walnut trees are scattered and there are very few regular plantations. Most of the trees are seedlings with hard nuts. A tree yields about 40 to 80 kg of nuts.

The other temperate nuts grown in India include the European chestnut (*Castania sativa*), which grows at from 1,600 to 2,300 metres above sea-level and the ornamental horse chestnut (*Aesculus indica*), both grown from seedlings and the Filbert or European hazel-nut (*Corylus avellana*) locally called 'Bindak' or 'Bhotia badam'. Wild forms of the latter are found growing in the Western Himalayas from 1,800 to 3,300 metres in partially-shaded gullies. The Turkish hazel-nut (*Corylus colurna*) also grows wild in the Himalayas.

Pecan nuts (*Carya illinoensis*) and macadamia nuts (*Macadamia ternifolia*) have been recently introduced and are under trial.

Some other minor temperate fruits are also grown in India. One of these is strawberry (*Fragaria* spp.). The fruit is a soft highly perishable berry, which is botanically an aggregate fruit. The plant is a small herb with shallow roots. The propagation is done by one-year-old runners. The runners should not be allowed to grow till after the fruit has been harvested. The soil is covered with straw mulch during fruiting or during freezing weather. Hence the name strawberry. The plants are planted generally about 22 cm apart on raised beds. Strawberry is grown mostly near Dehra Dun, Nainital, Mahabaleshwar and to some extent in Meerut near Delhi.

The other fruit is the Japanese persimmon (*Diospyros kaki*) belonging to the family Ebenaceae, which yields ebony wood. It is a monœcious tree and grows up to a height of 17 metres. It is often considered a sub-tropical fruit. It is cultivated mostly in the Kulu Valley. The propagation is by crown-grafting on seedlings of *Diospyros lotus*. The scions are kept covered with soil till they sprout. The adult tree requires little winter chilling and practically no pruning. The fruit is harvested when it has attained proper colour but is still hard. The berry becomes soft on ripening. Most varieties are astringent till they are fully ripe. Fuyu is a non-astringent variety with tomato-shaped fruit. Twentieth Century is a non-astringent and earliest variety. Hachiya is an astringent variety with oblong pointed fruit. Dai Dai Maru is a successful variety from the Nilgiris. The fruits can be ripened by keeping them with pears in airtight chambers for three days.

The ripening and removal of astringency can also be done by storing the fruits with tomato, mangosteen, passion fruit, cape gooseberry and more slowly with banana. The ethylene gas released by these fruits during their own ripening helps ripen and remove the astringency of persimmon.

The commercial trees of persimmon generally bear only female flowers and bear seedless fruit through parthenocarpy. Trees with male flowers and both male and female flowers on the same trees are also found. Fruit-thinning when the crop is very heavy helps the tree bear a crop regularly every year. Some of the other species related to persimmon and found in India are *D. tomentosa* (tendu), *D. lotus* (Amlok) and in South India, *D. discolor*, *D. embryopteris*, and *D. melanoxylon*, which yields Coromandel ebony-wood. Many other wild species of *Diospyros* are found in India.

The raspberry (*Rubus idaeus*), the blackberry and the purple raspberry, which are important bramble fruits in the west and bear aggregate fruits on two-year-old canes of bushy plants, are not grown commercially in India. However, some species like *Rubus ellipticus* (Heer or Hinsar) with yellow fruits and the dark-fruited raspberry locally called Kailkha are found growing wild in the Himalayas and the cultivation of the improved types in these areas should be possible. In fact, the cultivation of blackberries has been found quite successful at Coonoor and even at Bangalore.

PESTS AND DISEASES

Plant protection and pruning form the most important operations in the care of apple orchards.

Woolly aphis (*Eriosoma lanigerum*) is found in all parts of India and is active from March to December. The pest attacks primarily the underground roots of apple but the winged aphids also attack its aerial parts. It is controlled by the use of resistant root-stocks like Northern Spy and Merton 778, 779, 789 or 993. Quince, *Pyrus pashia*, 'Shiara' and *Cotoneaster bracillaris*, found wild in the Himalayas, are resistant to this pest. The undergound insects can be killed with paradichlorobenzene, which ought to be used sparingly. The aerial forms can be controlled by spraying, with .05% methyl demeton, nicotinesulphate and soft soap or Basudin 1-640. Biological control with *Aphilinus mali*, which was introduced in Kulu in 1937, has also been found effective in Kashmir. The lady-bird beetle, *Coccinella septumpunctata*, has been found effective for this purpose in the Kumaon Hills.

San Jose scale (*Quadraspidiotus perniciosus*) attacks all temperate fruits, but is most serious on apple. It was first found in Kashmir from where it spread to the other areas. The insect lives under a small

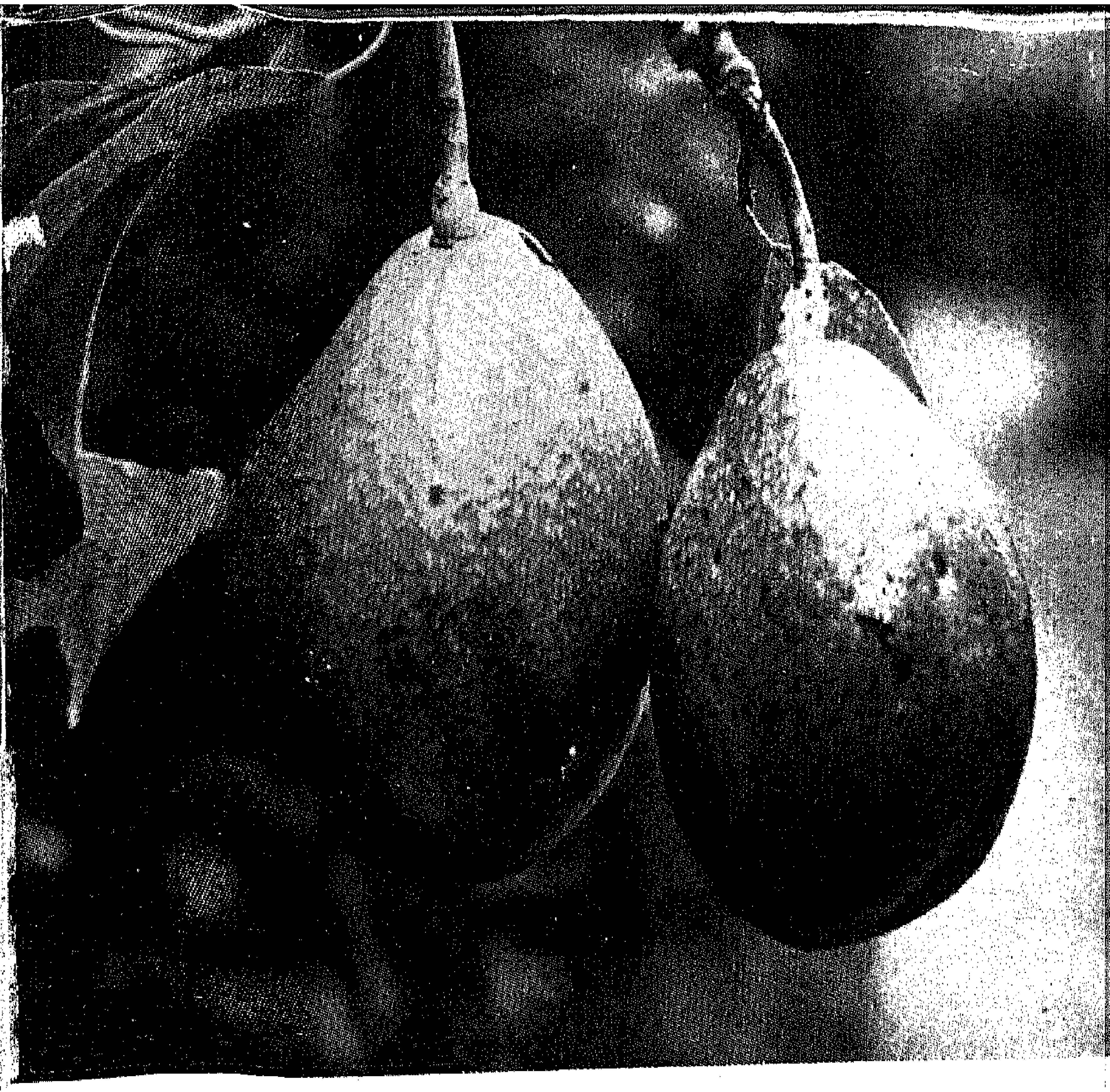
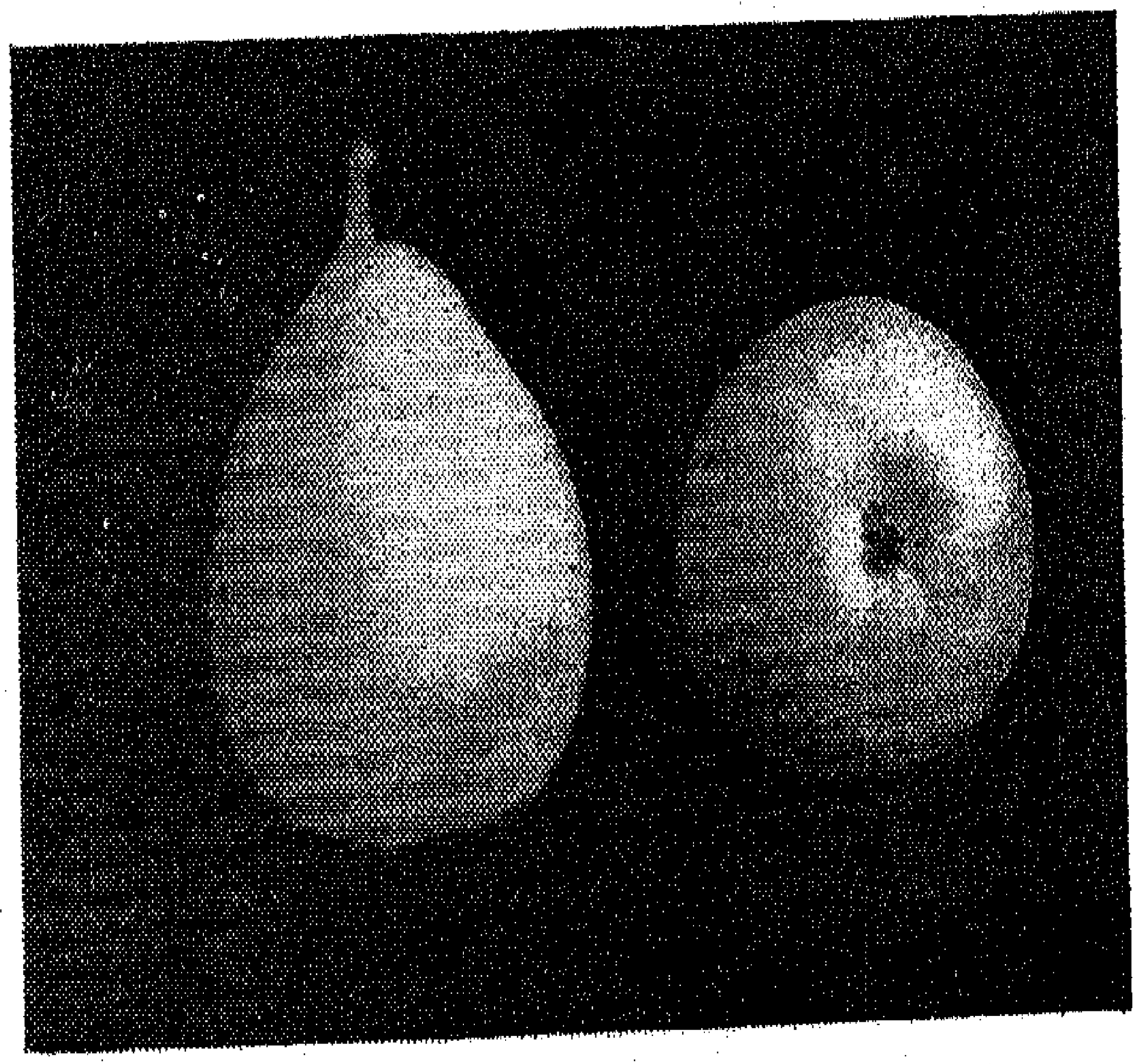


Plate 17. AVOCADO (*Persea americana*) (*page* 148)

Plate 18. NAKH, A HARDY OF PEAR (*Pyrus pyrifolia*) (*page* 161)



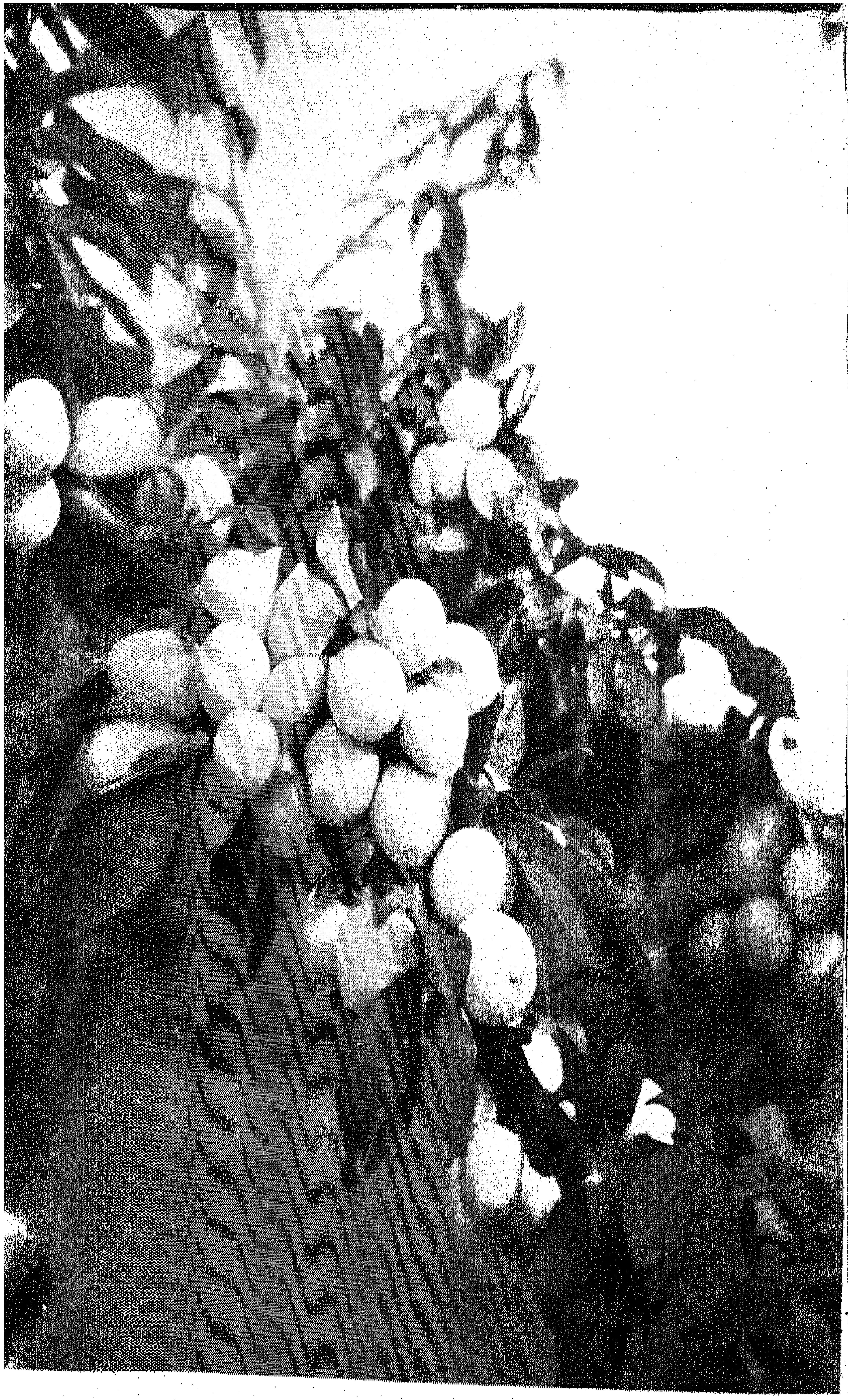


Plate 19. JAPANESE PLUM (*Prunus salicina*)
(*page 164*)

scale, which appears as a greyish powder on the branches and as pinkish dots on the fruit. It is controlled by spraying diesel oil emulsion containing Bordeaux mixture or 3.0% Esso tree spray oil. Lime sulphur or dinitrocresol with Euphyton can also be used. The nursery stock should be free from the pest.

The grubs of the root-borer (*Lophosternus hugelii*) attack the roots of the plant and can be controlled by applying powdered paradichlorobenzene under the soil surface.

Apart from the above-mentioned pests, some fungal diseases are also found. Powdery mildew (*Podosphaeria leucotricha*) is a fungal disease appearing in apple orchards every year in Kashmir. Some varieties like Jonathan are especially susceptible to it. The diseased shoots should be pruned off. This serious disease is controlled by six lime sulphur sprays of graded dilutions (1/25 to 1/100) from the time of winter pruning till after blooming, sprays of micronized wettable sulphur, or Aureofungin (4.5 gm in 100 gallons of water).

White root rot and collar rot (caused by *Rosellinia* sp.) are found under high humidity. Soil aeration and drainage are the remedy for these diseases. In Himachal Pradesh the fungus *Phytophthora cactorum* causes foot and collar rot in apple nurseries. Black rot (*Sphaeropsis malorum*), which mainly affects the roots, is found in the Kumaon Hills and Himachal Pradesh.

Apple scab (*Venturia inequalis* and *V. prina*) is not as serious in India as in some other countries, but the variety Ambri in Kashmir is highly susceptible to it. Lime-sulphur sprays or 0.2% Captan controls this disease.

Stem black (*Coniothecium chomatosporum*) is the most serious disease of apple in the Kumaon Hills. It enters through the pruning wounds. The affected branches turn jet-black and ultimately die. The pruning wounds should be painted with linseed oil or lanolin containing equal quantities of red lead and copper carbonate. This treatment will also control the pink disease, *Pellicularia salmonicolor*, which affects many species especially in poorly-drained soils, and the stem brown disease caused by *Botryosphaeria ribis*.

Peach leaf curl is caused by the fungus *Taphrina deformans* and

T. mume. The fungus attacks the leaves of peach which become curled and yellowish or reddish. The internodes become shortened and swollen. It can be controlled with a single spray of 0.2% Ziram, 0.1% Ferbam, lime sulphur spray or Bordeaux mixture before the swelling of buds. The curling of the leaves of peach is also caused by the aphis (*Brachycandus pruni*). In this case the leaves do not turn yellowish or reddish. It can be controlled by spraying tobacco decoction before the buds swell.

One of the most common diseases of plum in India is the bacterial gummosis, caused by the bacterium *Pseudomonas syringae*. It enters through the pruning wounds and causes exudation of gum. It can be prevented by mixing dihydro-streptomycin sulphate in the paste used for covering pruning wounds.

Other diseases of these fruits are the brown rot caused by *Sclerotinia fructigena*, sooty bloth (*Leptothyrium pomi*) and soft rot of the fruit (*Penicillium expansum*).

The growth of lichens on trees of temperate fruits is sometimes a problem. They smother the dormant buds. Application of one and a half per cent solution of caustic soda to the trees in the dormant season once in five years keeps the growth of lichens under check.

APPENDIX

WILD AND CULTIVATED FRUITS FOUND IN INDIA

Botanical Name 1	Family 2	Country of Origin 3	Common Names Inc. Indian Names 4	Remarks 5
Actinidia chinensis Planch.	Actinidiaceae	China	Chinese gooseberry	A recent introduction; the oval fruits have flavour of gooseberry.
Aegle marmelos Correa	Rutaceae	North India	Bengal quince, bael, bel, bilva, shul, bil, maredu, vilvam, bilpatre	Distribution : semi-wild all over India; one form not commonly found has more numerous and smaller leaflets.
Aesculus indica Colebr (*A. glabra*)	Hippocastanaceae		Indian horse chestnut, pangar, bankhor, torjaga, kanur, ravi-gun, hane, hanudun	Found in Kashmir.
Ampelocissus latifolia				Vines like grapes; found wild in Bihar.
Anacardium occidentale L.	Anacardiaceae	Tropical America	Cashew, kaju, kaju badam, hijle badam, jidi-mamidi, munthamamidi, mindiri, geru bija	Found in Kerala, Madras, Andhra, Mysore and Assam.
Ananas comosus Merr. (*Ananas sativus*)	Bromeliaceae	Brazil	Pineapple, ananas, anaras, kazhudhachakka	Found in Kerala and Assam.

1	2	3	4	5
**Annona atemoya* Hort.	*Annonaceae	A man-made hybrid found in Israel, Florida, Egypt and India	Atemoya, lakshman phal	Found in Andhra Pradesh.
Annona cherimola Mill. (*A. tripetala*)	—do—	Tropical America	Cherimoya, hanuman phal, cherimoyer	A recent introduction; a few trees are found in Central and South India.
Annona diversifolia Safford	—do—	Tropical America	Ilama, white anona	Introduced into South India.
Annona muricata L.	—do—	America—West Indies	Soursop, mamphal, guanabana, durian blanda	Found in some parts of Maharashtra and Madras.
Annona reticulata L.	—do—	Tropical America	Bullock's heart, bull's heart, Ramphal, nona	Found in South India and Assam.
Annona squamosa L.	—do—	—do—	Sweet sop, custard apple, sugar apple, sharifa, sitaphal, ata	Found wild in the eastern parts of Andhra Pradesh and near Hyderabad.
Artocarpus altilis Fosberg =*A. communis* (*A. incisus*, *A. incisa*)	Moraceae	Malaya, Pacific Islands	Bread fruit, vilayati phanas, seema panasa, seemapila	Found in Madras, Assam, Maharashtra; not a common fruit.
Artocarpus heterophyllus Lam. (*A. integra*, *A. integrifolius*, *A. integrifolia*)	—do—	India	Jack-fruit, kathal, panasa, kanthal, pilapalam, halasu, chakka	Found on Western Ghats and in Assam, Bengal and Bihar.
Artocarpus hirsuta Lam.	Moraceac	Probably India	Aini, hebbhalasu, anjili, pejata, pat phanas	Found in Western Ghats and Deccan Peninsula.
Artocarpus lakoocha Roxb.	—do—	India to Malacca	Monkey jack, barhal, dephal, wotomba, kammaregu, vatehuli, daua	Found wild in Assam, Bengal and U.P., in the sub-Himalayan areas and on the Western Ghats.
Averrhoa carambola L.	Oxalidaceae	India-China	Carambola, kamrakh	Found in all frost-free areas of India.
Averrhoa bilimbi L.	—do—	India-Malaya	Bilimbi, tree sorrel, cucumber tree	An introduced plant found in a few gardens in South India.
Baccaurea sapida Muell.-Arg.	Euphorbiaceae		Latka, lateku, kanazo	Fruit of the size of a large gooseberry, edible; seeds with pulpy aril; found in North Bengal, Assam and Andamans.
Carica candamarcensis Hook. f.	Caricaceae	Ecuador	Mountain papaya, kondapapaya	Semi-wild stray trees found in the Nilgiris above 1500 metres.
Carica papaya L.	—do—	Tropical America	Papaya, papita, arind-kharbuza, pappaiya, pappali, pappayi, boppayi, parangimara	Found all over India in frost-free areas.
Carissa carandas L.	Apocynaceae	India-Java	Karonda, caronda, karamcha, karavanda, karamarda, vaka, kalakkay, karekayi	Found throughout India.

*Annona and Annonaceae are sometimes spelt with a single 'n'.

1	2	3	4	5
Carissa grandi flora A.D.C.	Apocynaceae	South Africa	Natal plum	An introduced plant cultivated around Baroda.
Carissa inermis Vahl (*C. macrophylla*)	—do—	Probably South India		Found wild throughout Deccan Peninsula.
Carissa spinarum L. (*C. diffusa*)	—do—	India	Karmadika, karaunda, kalivi, chiru, kila, anka, kol, gan, garaunda	Found throughout India, especially in Kashmir and Punjab.
Carya illinoensis Koch (*Carya pecan, Hicoria pecan*)	Juglandaceae	Southern U.S.	Pecan, Pecan nut	Tried in India but not yet proved a success.
Casimirao edulis Llav. & Lex.	Rutaceae	Mexico	White sapote, Cochil sapota	A sub-tropical edible fruit found in some gardens in India; belongs to the family of citrus fruits.
Castanea sativa Mill =*C. vulgaris* Lam. (*C. vesca*)	Fagaceae	North Africa-Asia Minor	Chestnut, sweet, Spanish or European chestnut, Punjabi geer	Cultivated in Kashmir, Assam and other Himalayan areas; not grown commercially.
Chrysophyllum cainito L.	Sapotaceae	West Indies and Central America	Butter lime, cainito, West Indian star apple	Grown in warmer parts of India, especially Baroda and Bombay.
Citrus assamensis Bhattacharya and Dutta	Rutaceae	India	Ada-Jamir	Found semi-wild in Assam. It is similar to the gajanimma or badvapulli of South India and should be treated as a botanical variety of *C. pennivesiculata.*
Citrus aurantifolia Swingle (*C. medica* var. *acida*)	Rutaceae	Probably India	Key lime, Mexican lime, sour lime, khata limbu, elumichai, nimma, limbe, kagdi, kagzi, nimbu, nimbuka, pattinebu, erumichinarakam	Grown all over India.
Citrus aurantium L. (*C. aurantium* var. *bigaradia*)	—do—	India	Sour orange, Seville orange, bitter orange, soh-than, karun jamir, naranj, khatta, narangam, narattai, mallika narangi, heralay, heralle	Not a common tree in India.
Citrus grandis Osbeck (*C. maxima, C. decumana*)	—do—	South-East Asia	Pummelo, pomelo, shaddock, chakotra, betabi, mahatabi, obakotru, panis, papnasa, sakkota, pamparamasam, pambalpimasu, pampalamasam, rabab-tenga, soh-myngor	Found all over India in the humid regions.
Citrus indica Tanaka	—do—	India	Indian wild orange, humitia-tenga	Found wild at high altitudes in Assam. Does not survive in the plains.
Citrus jambhiri Lush.	—do—	—do—	Rough lemon, Florida Rough, Mazoe lemon, Citronelle, jambheri, jamburi, soh-myndong, khatti, jattikhatti, madhul, kada narangi	A common rootstock found all over India.

1	2	3	4	5
Citrus karna Raf.	Rutaceae	India	Id-lemon, karna orange, karna, karna khatta, id-nimbu, soh-sarkar	Found all over India. Useful rootstock for citrus in heavy soils especially for grapefruit.
Citrus latipes Tanaka	—do—	Eastern part of India	Khasi papeda, soh-khymphorshreih, soh-shyrkhoit	Found in Assam.
C. limettioides Tanaka	—do—	India	Indian sweet lime, Palestine sweet lime, limun helw, mitha nimbu, sharbati, mitha, mitha kagzi, moumuri, nenupandu, kolumi-changai, nenumapandu, mou-muri, soh-bakhlein, shinimbu, sakkar limbu	Grown in Central and Northern India.
Citrus limon Burm. (*C. medica* var. *limon*, *C. limonimedica*, *C. limonia*)	—do—	East Asia	Lemon, lebu, baranimbu, perya yelumichai, nimbu, jambira, nemu, pahari kaghzi, goranebu, motulimbu, idalimbu, thoralimbu, bijapura, bijori, bijapuram	The true lemons are tree lemons like the varieties Lisbon and Villa Franca and are rarely found in India. The bush type of lemons found in India are hybrids between citron and lemons and should be designated as *C. medica* var. *limonum* (Lush).
Citrus limonia Osbeck	Rutaceae	Probably India	Canton lemon, rangpur (lime), mandarin lime, cravo lemon, marmalade orange, Kusai lime, modulli, sindhuri nemu-tenga, moognimbe, surkh nimbu, Sylhet lime	Found in the lower Himalayas and hills in India; an important rootstock; a mandarin-like fruit, which should not be confused with lime or lemon.
Citrus macroptera var. *annamensis* Tanaka (*C. combara* Raf.)	—do—	Probably India-Burma region	Anam papeda, satkara, soh-kwit, hampur-arong, chamarbaphang	A common plant in Khasi Hills in Assam.
Citrus maderaspatana Tanaka	—do—	South India	Kichili, vadlapudi, Guntur sour orange	This fruit resembling the sour orange is found in Guntur area of Andhra Pradesh; not found in North India.
Citrus madurensis Lour. (*C. mitis*)	—do—	China	Calamondin, Hazara, China orange, orange-quat	Grown as an ornamental or hedge plant; the fruits hang on the tree after the next crop has been set.
Citrus medica L.	—do—	India	Citron, turanj, madhu-kankar, mokri, begpura, bijoru, mahalunga, mavalung, gilam, rusa-kam, matalanarakam, mahaphala, lungamu, madala kadaranorathai	Found all over India.

1	2	3	4	5
C. megaloxycarpa Lush.	Rutaceae	India	Sour pummelo, amilbed, desi kalamba, bor-tenga, jamir-tenga, holong-tenga, hukma-tenga	Grows luxuriantly in lower ranges of Eastern Himalayas.
Citrus paradisi Macf. (*C. maxima* var. *uvacarpa*)	—do—	West Indies	Grapefruit	Cultivated in North India, Gujarat and Maharashtra.
Citrus pennivesiculata Tanaka	—do—	India	Gajanimma, baduvapulli, attara, sinderum	Found mostly in South India.
**Citrus pseudolimon* Tanaka	—do—	India	Hill lemon, kumaon lemon, galgal, kilkil, pahari nimbu, soh-long	Found commonly in lower Himalayas.
Citrus reticulata Blanco (*C. nobilis*, *C. chrysocarpa*)	—do—	Southern China and Cochin-China	Mandarin, kidglove orange, loose-skinned orange, tangerine, kamla, khasi orange, santara, sangtara, pulli, soh-niamtara, sumthira	The name orange is often used in India for this species, but the English word orange denotes a tight-skinned orange (*C. sinensis*).
Citrus rugulosa Tanaka	—do—	India	Indian grapefruit, attani, attoni	Found in the submontane areas.
Citrus semperflorens Lush.	—do—	—do—	Sadaphal, nardaba	Found all over India, but not a common plant.

* It would be more appropriate to treat the hill lemon as a botanical variety (var. *decumana*) under *C. limon.*

Citrus sinensis Osbeck (*C. aurantium* var. *sinensis*)	Rutaceae	China	Sweet orange, orange, malta, Sathgudi, Chini, Batavian, tight-skinned orange (Mosambi is a variety of this fruit grown mostly in Maharashtra.)	Found in Punjab, Rajasthan, U.P., Maharashtra and Andhra Pradesh. All varieties of this fruit have been introduced from abroad.
Clausena indica Oliver	—do—	India		Found in evergreen forests of Western Ghats; the fruits are half-inch across and edible; aromatic leaves are used for flavouring curries.
Clausena lansium (Lour.) Skeels (*Cookia wampee*, *Clausena wampi*)	—do—	South China	Wampee	Introduced into India; a small tree with yellow fruits looking like small sour limes; can be used for making a jam; not cultivated much.
Cydonia oblonga Mill. (*Cydonia vulgaris*)	Rosaceae	South Asia (uncertain)	Quince, beh, bihi, amritphala, safarjab, bumchunth, shimaimathala, simadanimma, simedalimbe, bamsutu, bamtsuntu	Cultivated in Kashmir.
Cyphomandra betacea (Cav.) Sendt.	Solanaceae	Peru	Tree tomato	Cultivated on the hills in tropical regions.
Dillenia indica L. (*D. speciosa*)	Dilleniaceae	East India	Chalta, karambel, karmal, peddakalinga, uvu, uva, betta kamgala, chalita, punna, outenga	Occurs as a wild plant mostly in Assam and Bengal, where a chutney is made from the round ball-shaped calyx of the fruit; grows in moist places near streams all over India.

1	2	3	4	5
Diospyros discolor Willd. —*D. mabola* Roxb.	Ebenaceae	Philippines	Mabola persimmon, butter fruit, vilayati gab	Found in Assam, Bihar and extreme south; the quince-like fruits are edible.
Diospyros kaki L. (*D. chinensis*)	—do—	China	Persimmon, Japani phal, halwa tendu, dieng-iong, soh-tang-jong	Cultivated in the Kulu valley in H.P. and at Coonoor in Nilgiri Hills.
Diospyros lotus L.	—do—	West Asia—Himalayas—China	Date-plum, persimmon, amlok	Found wild in the Himalayas.
Diospyros peregrina (Gaertn.) Gurke = *D. embryopteris* Pers. (*D. malabarica*)	—do—	India-Malaya region	Gaub, kalatendu, makurkendi, timburi, temburni, tinduki, gabu, kavikattai, tumbi, hole-tupare, kusharta, panachi, vananji, kendu, dhusaro-kendu, kattati	Found all over India near streams; the small dark fruits are edible.
Diospyros tomentosa Roxb.	—do—	India	Ebony persimmon, tendu, kendu, temru kend, kyon, cittatumiki, mancitumiki, tumiki, tumbi, tindura, tumari, timburani, kinnu, tumri, tumki	Found wild in North and Central India; the small fruits are edible.
Durio zibethinus L.	Bombaceaceae	East Indies-Malaya	Durian, civet fruit	A few trees are grown at the foot of the Nilgiris in South India.
Elaeocarpus floribundus Bl. (*E. serratus*)	Elaeocarpaceae	India-Malaya	Jalpai, ulangkarei, uttrachham, perinkara, avil, nallakara, valiya-kara, karmava, jolopari	Grows wild in Assam and Bengal and on the Western Ghats; fruits resemble the olive; cooked or pickled.
Emblica-officinalis Gaertn. (*Phyllanthus emblica* L.)	Eupharbiaceae	Tropical Asia	Myrobalan, emblic myrobalan, Indian gooseberry, amla, aonla, amlika, amali, ambala, amala-kamu, usirikai, nelli, amalka	Cultivated mostly in U.P. but found all over India.
Eriobotrya bengalensis Hook. f.	Rosaceae	India-Malacca	Maya, dieng-signerei, larubandha, bolanchin	Found in Eastern Himalayas upto 5000 feet; used for timber, shuttles; fruit inedible.
Eriobotrya japonica Lindl. (*Photinia japonica*)	—do—	China	Loquat, Japan plum, Japanese medlar, lakotte, ilakotta, nokkota	Cultivated at the foot of the Himalayas.
Eugenia kurzii Duthie	Myrtaceae	India	Jaman, sunom, bagijamuk	Found in Assam, Sikkim, at upto 5000 feet; also in Martaban, and the Andamans; fruit is edible.
Eugenia uniflora L.	—do—	Tropical South America	Surinam cherry, Brazil cherry, Pitanga	Found in gardens in Bangalore, Bombay and Baroda.

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Euphoria longan Steud (*E. longana*, *Nephelium longana*, *Dimocarpus longan*)	Sapindaceae	India-Burma	Longan, lungan, ashphal, tokra, wumb, puvatti, shempuvan, kanakindeli, malakcota, pasakota, shempuna, poripuna, mulei, naglichi	Found in Assam, Bengal; a few trees at the foot of the Nilgiri Hills in South India.
Feijoa sellowiana Berg.	Myrtaceae	Brazil	Pineapple guava, feijoa, Newzealand banana	Not grown commercially, found on hills at elevations upto 3500 feet.
Feronia limonia (L.) Swing. (*Limonia acidissima*)	Rutaceae	India	Wood apple, elephant apple, kaith, kaitha, kapith, Indian wood apple, bilin, kait, katbel, kavit, kotha, kothum, velaga, bela, vilanga, vila, vilatti	Occurs wild all over India.
Ficus auriculata Lour. =*F. roxburghii* Wall (*F. macrophylla*)	Moraceae	India	Timla, tirmal	Grows mostly on the lower Himalayas; the leaves and fruits are large; fruit is edible but insipid.
Ficus carica L.	—do—	West Asia	Fig, anjir, dumar, anjuru, manjmedi, simayatti, tennati, anjura	Cultivated around Poona, Mysore and Lucknow.
Ficus glomerata Roxb. =*F. racemosa* L. (*F. vesca*)	—do—	East Indies to Australia	Gular, umar, dumar, jagyadumbar, umbar, atti, bodda, paidi, udum baramu, athi, dimri	Fruits borne in clusters on trunk and main branches; found all over India near streams, etc.; fruit is not edible but can be ground into flour.
Ficus hispida L. f.	Moraceae	South Asia to Australia	Jangli anjir, bodamamidi, brammadi, daduri, dagurin, gobla, kagsha, katgularia, dumoar, kakodumar, bhokada, bokria, kalaumber, kharoti, dhedaumaro	Found in shady places all over India; the leaves are opposite and the fruits often borne in pairs are of poor quality.
Ficus palmata Forsk.	—do—	India to Egypt	Phagwara, anjiri, bedu, khemri, pepri, manjimedi	Found in N.-W. India, U.P. and Rajasthan; the fruits are of fairly good quality, especially on hills; leaves are used as fodder.
Flacourtia indica Merr. (*F. ramaontchi*)	Flacourtiaceae	India and Tropical Africa	Governor's plum, Batoko plum, Madagskar plum, ramontchi, kandregu, katukala, sottaikala, hattari mullu, hunmunki, bilangra, baichi, kanju, binja, katai, kankod, bhekal, kaker, paker	Found in Assam, Bengal, and Maharashtra.
Flacourtia jangomas Raeusch. =*F. cataphracta* Roxb.	—do—	India	Puneala plum, paniala, talispatra, tambat, kuragayi, saralu, vayangarai, chankali, goraji, kanji, talisam, vayankatha, baincha, baichi	Found at foot of the Himalayas and in South India; fruit is inedible.
Fortunella japonica and *F. margarita* Swingle (*Citrus japonica*)	Rutaceae	South China	Kumquat (Maroomi and Nagami)	The small evergreen shrub can withstand cold weather and is cultivated as an ornamental plant.

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Fragaria chiloensis x *F. virginiana*	Rosaceae		Strawberry, garden strawberry, ishtabar	Cultivated in Kashmir, Dehradun valley in U.P., at Mahabaleshwar near Poona and on a small scale near Delhi.
Fragaria daltoniana Gay (*F. sikkimensis*)	—do—	Eastern Himalayas	Bhumla	Native of Eastern Himalayas; found above 9000 feet.
Fragaria indica Andr. (*Duchesnea indica* Focke.)	—do—	India	Indian or mock strawberry	Occurs wild in the Himalayas and hills of South India; fruit insipid.
Fragaria nilgerrensis Schlecht.	—do—	India and China	Nilgiri strawberry	Fruit of inferior quality; found in South India and in Eastern India, above 5000 feet.
Garcinia cowa Roxb (*G. kydia*)	Guttiferae	India	Cowphal, cowa, kau, kaphal, kujithekera, kauthekara	Grows in Assam, Bengal and Orissa, fruit edible; bark yields a yellow dye.
Garcinia indica Choicy	—do—	—do—	Kokum, kokam butter tree, mangosteen oil tree, brindonia tallow tree, kokam, kokan, amsol, bhirand, katambi, ratamba, murgal, punampuli	Found on the Western Ghats and the Nilgiris; seeds used for making butter and fruits for culinary purposes; cultivated around Bombay.
Garcinia mangostana L.	—do—	Malaya-Peninsula	Mangosteen, mangusta, mangustan	A most delicious fruit; only a few trees are grown at the foot of the Nilgiris and in Tinnevelly in Madras State.
Garcinia xanthochymus Hook. f. =*G. tinctoria* Dunn.	Guttiferae	India-Burma	Dampel, tamal, chalata, karamala, ota, chunyel, jharambi, ivarumedi, tamalamu, kulavi, malaippachai, mukki, tamalam, devagarige, anavaya, cheoro, sitambu	Found wild in lower Eastern Himalayas and Maharashtra, Mysore, Madras and Kerala.
Grewia elastica Royle =*G. vestita* Wall. (*G. asiatica* var. *vestita*)	Tiliaceae	India	Pharsia, dhaman, bimla, dhamni, mirgichara, manbijal	Found in sub-Himalayan tract from Garhwal to Sikkim, Central India, the Western Ghats, and Malabar; a tall tree with edible fruit.
Grewia subinaequalis D.C. =*G. asiatica* Mast.	—do—	—do—	Phalsa, falsa, dhamin, parusha, shukri, jana, nallajana, phutiki, palisa, tadachi, buttiyudippe, tadasala, pharasakoli	Cultivated especially around Baroda.
Grewia tillifolia Vahl	—do—	Eastern Tropical Africa	Dhamni, dhamin, pharsa, daman, dalmon, charachi, ettatada, sadachi, unnu, thadsal, butale, chadicha, dhamuro	A large tree found at foot of the Himalayas, down to South India; fruit is edible.
Juglans regia L.	Juglandaceae	South-East Europe	Walnut, English walnut, Persian walnut, akhrot, akhor, krot, doon	Grows semi-wild in Kashmir and Himachal Pradesh.

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Lansium domesticum Correa	Meliaceae	Malaya	Langsat, daku, lansa	Cultivated in South India in a few places.
Litchi chinesis Son. (*Nephelium litchi* Cambess.)	Sapindaceae	China	Litchi, leechee, lychee	Cultivated mostly in Bihar; also in U.P., Punjab and Bengal.
Macadamia ternifolia F. Muell	Proteaceae		Macadamia nut, Queensland nut, Australian nut	Being tried in the Himalayas and on the hills in South India.
Madhuka indica J.F. Gmel. (*Madhuka latifolia* Macbride, *Bassia latifolia*)	Sapotaceae	India	Mohwa, mahua, maul, mahula, mahudaippa illupei, elupa, hippe, poonam, ilupa, mohula, moha, madgi	Fruits very inferior; flowers used as food and for making liquor; seeds give an oil; grows wild mostly in Central India.
Malpighia glabra L.	Malpighiaceae	South America	Barbados cherry	Very recently introduced into India; a few bushes cultivated in gardens; richest source of vitamin C.
Malpighia punicifolia L.	—do—	—do—	West Indian cherry, vallari, simeyara nelli	Plants up to 8 metres tall.
Malus baccata var. *himalacca* (Maxim) Schneid.	Rosaceae	Himalayas	Himalayan crab apple, ban mehal, gwalam, baror, katsab, liu, lhizo, soh-shur-um; all wild apples are called 'Trel' in Kashmir	Found wild in the Himalayas.
Malus pumila Mill. (*Malus communis*, *Pyrus malus*, *Malus domestica*)	Rosaceae	Asia Minor to Western Himalayas	Apple, seb, seo, sebu, kushu, chunth	Cultivated in the Himalayas and to some extent in the Nilgiri Hills.
Malus sikkamensis Hook. f.	—do—	North India		Allied to *M. baccata*, but more woolly and much larger red fruits; wild in Sikkim and Bhutan from 7,000 to 10,000 feet.
Mangifera indica L.	Anacardiaceae	India-Burma	Mango, am, amba, amb, amri, mamidi, mavi, manga, mau, amram, mavu, cutam, mangkay	Cultivated all over India.
Mangifera sylvatica Roxb.	—do—	India	Ban-am, chuchi-am, kathorkung	Occurs wild from Nepal to Assam in the lower Himalayas.
Manilkara hexandra (Roxb.) Dubard (*Mimusops hexandra*)	Sapotaceae	Probably India	Khirnee, kirni, khirkhejur, ranjana, rayan, raini, manjipala, pala, palla, pallai, bakula, khiri, khirakuli	Used as a rootstock for sapota; its thin white date-like fruits are edible; found mostly in Central and South India.
Monstera deliciosa Liebm.	Araceae	Mexico-Guatemala	Ceriman	Not grown in India for fruit; cultivated only as an ornamental plant in gardens.
Morus alba L.	Moraceae	China	White mulberry, silk mulberry, tut, tutri, ambat, shetur, shehtoot, reshmi chattu, pippali pandu chettu, musukette, kambli chedi, hipnerle, tuticoli, tul, shahtul	Grows all over the plains and on the lower Himalayas; cultivated in Kashmir and Mysore for rearing silk worms.

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Morus indica Linn. (*M. cuspidata* Wall. *M. alba* var. *cuspidata* Bureau)	Muraceae	China		Found from Kashmir to Sikkim; used for rearing silkworms.
Morus laevigata Wall. ex Brandis	—do—	North India	Wild mulberry	Found wild in the outer Himalayas from Kashmir to Assam up to 4,000 feet.
Morus nigra L.	—do—	West Asia (Iran)	Black mulberry (vernacular names same as for *M. alba*)	Grown all over India for black fruits; the leaves are coarse and not good for rearing silk worms.
Morus serrata Roxb.	—do—	North India	Himalayan mulberry, karum, kimu, himu, tuti, dieng-soh-tungkhar	Grows wild in the Himalayas mostly in the Western region.
Musa acuminata Colla	—do—	South-East Asia	Wild banana, kattu vazhai	A wild species found in Assam and on hills of South India; a few cultivated types also come under this species.
Musa balbisiana Colla (*M. sapientum* var. *pruinosa*)	—do—	South-East Asia	Leaf banana, bonkera, kait dewsan, chungbi anguoba, athiya kel	Found wild in Assam, Sikkim and South India; some varieties cultivated for leaves, such as Elavazhai, Ginjaliarati or kallubale, belong to this species.
Musa nepalensis Wall.	—do—	Probably India		Found on lower hills of Nepal; has the habit of *Ensete superbum*.
Musa paradisiaca L. (covers almost all edible bananas)	Musaceae	Malaysia-India	Banana, kela, vazhai, bale, arati, vazha, rambha, anati	South India and East India are the main centres of cultivation. The dwarf bananas are also included under this species.
Musa sanguinea Hook. f. (*M. assamica*)	—do—	Assam		About three-foot tall ornamental plant found in Assam, fruit small variegated red and yellowish green.
Musa sapientum L.	—do—		Plantain; most of the cooking types come under this species	This name is now used for varieties which have originated as hybrids between *M. acuminata* and *M. balbisiana*. There are only a few varieties under this species.
Nephelium lappaceum L.	Sapindaceae	Malaya	Rambutan	Grown in the Nilgiris on a limited scale.
Olea europaea L.	Oleaceae	Mediterranean region	Olive, zaitun, zeitoun	Important oil crop of the Mediterranean region; only a few trees are found in orchard collections.
Olea ferruginea Royle (*O. cuspidata*)	—do—	N.-W. Himalayas—Baluchistan	Indian olive, kahu, kan, kao, bairbanj	Found in the Western Himalayas; the fruit is edible and yields an oil.
Passiflora edulis Sims.	Passifloraceae	Brazil (Tropical America)	Passion fruit, purple granadilla, purple passion fruit	Found on hills in South India.

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P. edulis var. *flavicarpa*	Passifloraceae	Tropical America	Yellow-fruited passion fruit	Found in plains in South India.
P. quadrangularis L.	—do—	—do—	Giant granadilla	Found in garden collections only.
Persea americana Mill. (*P. gratissima*)	Lauraceae	Mexico and West Indies	Avocado, Avocado pear, alligator pear	Bangalore and lower ranges of the Nilgiri Hills; introduced into India in recent times.
P. drymifolia Schlecht.	—do—	—do—	Mexican race of avocado	
Phoenix acaulis Buch & Roxb.	Palmae	North-Eastern and Central India	Dwarf date-palm, khajuri, janglikhajur, schap, lepcha chindi, jhari gond, funo, kurku; pindkhajur, biochind	A low, often almost stemless palm; commonly met with in dry ground from the sub-Himalayan tract to Central India. It flowers in cold season, and ripens its fruit in April and May.
Phoenix dactylifera L.	—do—	West Asia & Arabia	Date-palm, khurma, chuhara, kukyan, pind chirwi, jarikha, tamara, perich-chankay, somblonzi khajur, kasser, mach, karmah, pind chirdi, tar, perita, swonpalwon	Not cultivated commercially much in India due to damage to fruit from rain at the time of ripening.
Phoenix humilis Royle	—do—	China to Cochin-china		Found wild from Kumaon to Burma and down to Malabar; it is similar to *P. sylvestris*.
Phoenix rupicola T. Anders.	Palmae	India	Schiap	In Assam and Sikkim at 400 to 1400 feet; a beautiful palm of the lower hills of Darjeeling and Bhutan.
Phoenix sylvestris Roxb.	—do—	India-Madagascar	Wild date, date-sugar palm, East Indian wine palm, sendhi, kejur, salma, boichand, kharak, sandoleka-nar, itchumpannay, ita, ichal, pindakharjura, kharjura	Found all over India near streams; most abundant in Bengal, Bihar, on the Coromandel coast and in Gujarat; forms extensive forests in Rohilkhand; on the low ground along the Ramganga river, and on the plateau of Mysore between Shimoga and Tumkur.
Phyllanthus acidus Skeels (*Averrhoa acida, Phyllanthus distichus*)	Euphorbiaceae	India	Star gooseberry, Otaheite gooseberry, noar, hariphal, narkuli, cherambola, arunelli, rachausirike, kirnelli, nelli, lavani	A close relative of the aonla, found all over India; common in gardens of South India, Burma and Andaman Islands.
Physalis ixocarpa Brat.	Solanaceae	Mexico-Southern U.S.A.	Tomatillo, jamberry	
Physalis peruviana L. (*P. edulis*, Sims)	—do—	Tropics	Capegooseberry, tepari, tiparee, rashbhari (not to be confused with raspberry)	Cultivated all over India on a small scale.
Pistacia integerrima Stewart	Anacardiaceae	Western Himalayas	Kakra, galls, kakra singi, mar, guj, karkala sringi	Found wild on warm slopes of Western Himalayas.

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Pistacia vera L.	Anacardiaceae	West Asia	Pistachio, pista, pistalik, Pistachio-nut	Limited cultivation in Kashmir; the species *P. indica* has been mentioned to occur in the forests of India.
Poncirus trifoliata Raf. (*Citrus trifoliata*)	Rutaceae	China	Trifoliate orange	Grown in India as a hedge plant. Used as a rootstock for citrus in Japan.
Prunus amygdalus Batsch. (*Amygdalus communis, P. communis*)	Rosaceae	Persia-Afghanistan	Almond, badam, badum, bilati-badam, vadam-kottai, badam-vittulu.	Cultivated in Kashmir and Himachal Pradesh on a limited scale.
Prunus armeniaca L. (*Armeniaca vulgaris*)	—do—	China	Apricot, khurmani, khubani, cheare, zardalu, sadhi	Found at the lower elevations of Western Himalayas.
Prunus armeniaca var. *dasycarpa* (*P. dasycarpa*)	—do—		Black-fruited apricot	Cultivated in Kashmir; probably a hybrid *P. armeniaca* × *P. cerasifera*.
Prunus avium L.	—do—	Europe-West Asia	Sweet cherry, gilas, shal	Cultivated in Kashmir, Himachal Pradesh and the Kumaon Hills.
Prunus cerasus L.	—do—	—do—	Sour cherry, aelche	
Prunus domestica L.	—do—	—do—	Plum, alubokhara, European plum	Grown at high elevations
Prunus jacquemontii Hook. f.	—do—	Probably India		Related to *P. humilis*, but taller, flowers bright rose pink; found in Western Himalayas, Tibet and Afghanistan.
Prunus nepalensis Ser.	Rosaceae	North India		Difficult to distinguish from *P. padus* except that it has larger fruit; related to *P. cornuta*; inflorescence hairy, fruit 3/5″ across, found from Kumaon to the Khasi Hills at elevations of 4000-7000 feet.
Prunus padus L.	—do—	Europe	Bird cherry, jamana, likhar-u, hlosa, hlot-kung, bombaksing, zamb-chule, paras, kalakat, gidar-dak bart, zum	Found at high altitudes in the Himalayas and westward upto Great Britain.
Prunus persica Batsch. (*Amygdalus persica*)	—do—	China	Peach, aru, takpo, rek, sunnu, chimnanu, bem beini, aroo, chunun, mandata, shaftalu, ghwareshtai	Grown in India on the lower Himalayas and the foothill areas.
Prunus puddum Roxb. (*Prunus cerasoides*)	—do—	Himalayas	Paddam, paya, padmaksh	Found from Garhwal to Bhutan and Burma at altitudes of 3000 to 6000 feet.
Prunus rufa Wall.	—do—	Himalayas		Leaves narrow, flowers pink, solitary or in small clusters, fruit broadly elliptic, fleshy, red; found in Nepal and Bhutan at 10000 to 12000 ft.
Prunus salicina Lindl. (*P. triflora*)	—do—	China	Japanese plum, alucha	More common in India; also grows at the foot of the Himalayas.

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Psidium cattleianum Sab.	Myrtaceae	Brazil	Purple guava, strawberry guava	var. *lucidum* has yellow fruit.
Psidium guajava L.	—do—	West Indies to Peru	Guava, amrood, amrut, amrud, aim	Cultivated mostly in U.P., but found all over India.
Punica granatum L.	Punicaceae	South-East Europe to Himalayas	Pomegranate, anar, dalimb, deum; the wild type in the Himalayas is called daru	Cultivated mostly in Maharashtra and Gujarat.
Pyrus communis L.	Rosaceae	Europe	Pear, nashpati, French pear, tang, baghugosha	Cultivated on the hills in South India and on the Himalayas.
Pyrus khasiana Dcne.	—do—	......		Found wild in the Khasi Hills; fruit similar to that of *P. pashia*.
P. pashia	—do—	North India	Wild Himalayan pear, kainth, kenth	Found wild all over the Himalayas.
P. pyrifolia (*P. serotina*)	—do—	China	Shiara, wild Himalayan pear, batang, teng	Found semi-wild in the Himalayas.
P. pyrifolia var. *culta* Nakai	—do—	China	Nakh, desi nakh, Chinese sand pear	Cultivated at the foot of the Himalayas.
Rubus biflorus Ham.	—do—	Probably Himalayas	Whitewashed bramble, chanch, kantanch, khariara, akhreri, karer, ankren, bumbal, insra, batang, kalikalin, dher	With yellow roundish fruit; found wild in the Himalayas from Nahan to Bhutan at 7000 to 9000 ft.
R. ellipticus Smith	Rosaceae	Probably Yunan	Orange raspberry	Found on hills in South India, the Himalayas from Himachal to Khasi mountains at 2000 to 7000 ft.
Rubus fruticosus L.	—do—	West Asia	Brambles, blackberry, chhanch	Found in Kashmir at 3000 to 7000 feet.
Rubus gracilis Roxb. (*R. niveus* Wall.)	—do—	Himalayas-China		Fruit blue-black, small, found wild in the Himalayas from Kashmir to Bhutan at 5000 to 11000 ft.
Rubus lineatus Reinw. (*R. pulcherrimus* Hook.)	—do—		Gempe aselu	Fruit small, red or yellow, leaves with parallel veins and beautiful silvery sheen below; wild in Sikkim at 6000 to 9000 ft.
Rubus nutans Wall.	—do—	Himalayas	Sinjang	Fruit purple, glabose, edible; makes a good ground cover; wild in the Himalayas in U.P. at 8000 to 10000 ft.
Rubus rosaefolius Smith	—do—	Himalayas—East Indies		Small evergreen shrub; fruits 7/8" long, red, insipid; wild in the Himalayas from Kumaon to Khasi Hills at 3000-7000 ft. Fruit is frequently collected and sold in Darjeeling.

1	2	3	4	5
Spondias cythera Sonn. (*S. dulcis* Wild)	Anacardiaceae	Polynesia	Hog plum, Otaheite plum or apple, amra, ambrella	Introduced into India from West Indies.
Spondias pinnata Kurz. (*Spondias mangifera*)	—do—	Tropical Asia	Indian hog-plum, amara, ambodha, ambra	Cultivated in Bengal, Assam and Maharashtra, but found all over India; a small deciduous tree.
Syzygium cuminii Skeels (*Eugenia jambolana*)	Myrtaceae	East India-Malaya	Jambolan, jaman, Java plum	Grows all over India.
Syzygium fruticosum D.C.	—do—	—do—	Wild jaman, jamoa	Found mostly at the foot of the Himalayas.
Syzygium jambos Alston	—do—	East Indies	Rose apple, gulab jaman	Cultivated on a small scale in Bengal, Bihar, Assam, Orissa, Bombay and South India.
Tamarindus indica L.	Leguminosae	Tropical Africa-India	Tamarind, tamarando, imli, tintul, puli, amli, tintiri, koya, chinta, jajo, chinch, neddi, shenta, sitta, karangi, hunase, magyi	Grows all over India; an important condiment for cooking in South India; not cultivated in plantations.
Terminalia catappa L.	Combretaceae	India (Tropical Asia)	Indian almond, tropical almond, desi badam, bangala badam, jangli badam, nat vadom, tari katappa	Cultivated primarily as an ornamental tree.
Vitis barbata Wall. (*V. latifolia, V. lanata*)	Vitaceae			Found in the Khasi mountains in Assam.
Vitis discolor Dalz.	—do—			Fruits reddish purple, dry; found in Sikkim and the Khasi Hills.
Vitis lanata Roxb.	—do—	China-Himalayas	Kolo, kolonari, farilalara, mikrum-rik, asanjiyaor, asoja, paharphuta, purain	Fruit black, round, found in the Himalayas from 1000 to 7000 feet.
Vitis parviflora Roxb.	—do—		Barain	Found in Kashmir to Nepal, also in Eastern Bengal.
Vitis quadrangularis Wall.	—do—		Har-jora, hadjora, nallar, harsankar, asthisanhara	Berries very acidic; found from foot of the Kumaon Hills to Ceylon, Java, East Africa.
Vitis rotundifolia Michx.	—do—	South and Central United States	Muscadine grapes	Not commonly found in India.
Vitis rumcisperma Laws.	—do—			Wild species, found from Khasi Hills to Nepal.
Vitis vinifera L.	—do—	Caucasus region	Grapes, angoor, drakshi, dusch	Cultivated in Maharashtra, Hyderabad, Madurai in Madras and Punjab, etc.

1	2	3	4	5
Vitis labruscana Bailey	Vitaceae	North America		Cultivated around Bangalore.
Ziziphus glabrata Heyne (*Z. trinervia*)	Rhamnaceae		Karukata, karakattam, carukuva, vata dalla	A tree of Eastern Bengal, Bhutan and the Western Peninsula.
Ziziphus mauritiana Lam. (Z. vulgaris, *Z. sativa*)	—do—	India	Jujube, ber, bor	Found in all dry areas of India; the large trees mature fruits late in winter.
Ziziphus jujuba Lamk.	—do—	China	Chinese date, jujube	Not common in India.

Appendix II—NUTRITIVE VALUE OF INDIAN FRUITS

Sl.No.	Name of the fruit	Moisture. per cent.	Protein per cent.	Fat (ether extractives) per cent.	Mineral matter per cent.	Fibre per cent.	Carbohydrate per cent	Calcium per cent.	Phosphorus per cent.	Iron per cent.	Calorific value per 100 g	Carotene (Intern. Vit. A. Units per 100 g)	Vitamin B_1 (mg per 100 g)	Nicotinic acid mg/per 100 g	Riboflavin mg per 100 g	Vitamin C mg per 100 g
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Almond	5·2	20·8	58·9	2·9	1·7	10·5	0·23	0·49	3·5	655	trace	240	2·5	—	—
2.	*Aonla* (Indian gooseberry)	81·2	0·5	0·1	0·7	3·4	14·1	0·05	0·02	1·2	59	—	30	0·2	—	600
3.	Apricot (dry)	19·25	1·7	0·7	2·8	0·21	72·81	—	—	0·04	201	98	217	2·2	—	trace
4.	Apple	85·9	0·3	0·1	0·3	—	13·4	✓0·01	0·02	1·7	56	trace	120	0·2	30	2
5.	Avocado	73·6	1·7	22·8	1·1	—	0·8	0·01	0·08	0·7	215	—	—	—	—	13
6.	Banana	61·4	1·3	0·2	0·7	—	36·4	✓0·01	0·05	0·4	153	trace	150	0·3	30	1
7.	Bael	64·2	1·3	0·2	1·5	2·2	30·6	0·09	0·05	0·3	129	186	12	0·9	1191	15
8.	*Ber* (Zizyphus)	85·9	0·8	0·1	0·4	—	12·8	0·03	0·03	0·8	55	70	—	—	—	—
9.	Bilimbi	93·0	0·5	0·2	0·2	0·4	4·8	✓0·01	0·01	0·6	23	240	—	—	—	—
10.	Breadfruit	70·5	1·5	0·2	0·9	—	17·9	0·04	0·03	0·5	79	15	—	—	—	—
11.	Bullock's heart	70·8	1·4	0·2	0·7	—	20·9	0·01	0·01	0·6	91	trace	—	—	—	—
12.	Cape gooseberry	82·7	1·8	0·2	0·6	3·2	11·5	0·01	0·06	1·8	55	—	—	—	—	49
13.	Cashewnut	5·0	21·2	46·9	2·4	1·3	22·3	0·05	0·45	5·0	596	100	630	2·1	190	—
14.	Cashew fruit (apple)	87·9	0·2	0·1	0·2	—	11·6	0·01	0·01	0·2	48	—	—	—	—	—
15.	Custard apple	73·5	1·6	0·3	0·7	—	23·9	0·02	0·04	1·0	105	trace	—	—	—	—
16.	Dates (Persian)	20·1	3·0	0·2	1·3	2·1	67·3	0·07	0·08	10·6	283	600	90	0·8	30	trace
17.	Durian	58·0	2·8	3·9	1·2	—	34·1	✓0·01	0·05	1·0	183	20	—	—	—	—
18.	Fig	80·8	1·3	0·2	0·6	—	17·1	0·06	0·03	1·2	75	270	—	0·6	50	2
19.	Grape (blue variety)	85·5	0·8	0·1	0·4	3·0	10·2	0·03	0·02	0·4	45	15	40	0·3	10	3
20.	Grapefruit (Marsh Seedless)	88·5	1·0	0·1	0·4	—	10·0	0·03	0·03	0·2	45	—	120	0·3	20	31
21.	Guava (plains)	76·1	1·5	0·2	0·8	6·9	14·5	0·01	0·04	1·0	66	trace	30	0·2	30	299
22.	Guava (hill)	85·3	0·1	0·2	0·6	4·8	8·1	0·05	0·02	1·2	38	trace	—	0·3	—	16
23.	Jackfruit	77·2	1·9	0·1	0·8	1·1	18·9	0·02	0·03	0·5	84	540	30	0·4	—	—
24.	*Jaman*	28·2	0·7	0·1	0·4	0·9	19·7	0·02	0·01	1·0	83	—	—	—	—	—
25.	Karonda (dry)	18·2	2·3	9·6	2·8	—	67·1	0·16	0·06	39·1	364	—	—	—	—	—
26.	Langsat	86·5	0·8	0·4	0·6	2·3	9·5	0·02	0·03	0·5	4·4	13	89	—	124	1
27.	Lemon	85·0	1·0	0·9	0·3	1·7	11·1	0·07	0·01	2·3	57	trace	20 (juice)	0·1 (juice)	4	39 (juice)
28.	Lime	84·6	1·5	1·0	0·7	1·3	10·9	0·09	0·02	0·3	59	26	20 (juice)	0·1 (juice)	—	63
29.	Litchi	84·3	0·7	0·3	0·7	2·25	9·4	0·21	0·31	0·03	42	14	87·5	—	122·5	trace
30.	Loquat	87·4	0·7	0·3	0·5	0·9	10·2	0·03	0·02	0·7	46	—	—	—	—	—
31.	Mango (green)	90·0	0·7	0·1	0·4	—	8·8	0·01	0·02	4·5	39	150	—	—	30	3
32.	Mango (ripe)	86·1	0·6	0·1	0·3	1·1	11·8	0·01	0·02	0·3	50	4800	40	0·3	50	13
33.	Mangosteen	84·9	0·5	0·1	0·2	—	14·3	0·01	0·02	0·2	60	—	—	—	—	—
34.	Orange	87·8	0·9	0·3	0·4	—	10·6	0·05	0·02	0·1	49	350	120	0·3 (juice)	60	68
35.	Papaya	89·6	0·5	0·1	0·4	—	9·5	0·01	0·01	0·4	40	2020	40	0·2	250	46
36.	Passion fruit	76·3	0·9	0·1	0·7	—	22·0	✓0·01	0·06	2·0	93	90	—	—	—	—
37.	Peach	90·1	1·5	0·2	0·6	—	7·6	0·01	0·03	1·7	38	trace	20	0·2	1	1
38.	Pear	86·9	0·2	0·1	0·3	1·0	11·5	0·01	0·01	0·7	47	14	20	0·2	30	trace
39.	Persimmon	79·6	0·8	0·2	0·4	—	19·0	0·01	0·01	0·3	81	1710	—	—	—	—
40.	Pineapple	86·5	0·6	✓0·1	0·5	0·3	12·0	0·02	0·01	0·9	50	60	—	—	120	63
41.	Plum (red variety)	89·8	0·7	0·2	0·4	—	8·9	0·02	0·02	0·5	40	230	120	0·3	30	1
42.	Pomegranate	78·0	1·6	✓0·1	0·7	5·1	14·6	0·01	0·07	0·3	65	—	—	—	100	16
43.	Pummelo	88·0	0·6	✓0·1	0·5	0·6	10·2	0·03	0·03	0·1	45	200	30	0·2	—	20
44.	Raisins (dried grapes)	18·5	2·0	0·2	2·0	—	77·3	0·10	0·08	4·0	319	—	60	0·5	—	trace
45.	Rose apple	89·1	0·7	0·2	0·3	—	9·7	0·01	0·03	0·5	43	—	—	—	50	—
46.	Strawberry	87·8	0·7	0·2	0·4	1·1	9·8	0·03	0·03	1·8	44	—	30	0·2	—	52
47.	Tree tomato	82·7	1·5	0·2	1·1	4·2	10·3	0·01	0·03	0·7	49	540	—	—	—	trace
48.	Walnut	4·5	15·6	64·5	1·8	2·6	11·0	0·10	0·38	4·8	687	10	450	1·6	—	—
49.	Wood apple	69·5	7·3	0·6	1·9	5·2	15·5	0·13	0·11	0·6	97	—	—	—	170	—

(Source : *Fruit Culture in India*, ICAR, New Delhi, 1963)

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20.	Ranjit Singh	*Shri D. R. Sood*	2.00
21.	Hari Narayan Apte	*Dr. M. A. Karandikar*	1.75
22.	R. G. Bhandarkar	*Dr. H. A. Phadke*	1.75
23.	Muthuswami Dikshitar	*Justice T. L. Venkatarama Aiyar*	2.00
24.	Mirza Ghalib	*Shri Malik Ram*	2.00
25.	Ramanujacharya	*Shri R. Parthasarathy*	2.00
26.	Ishwar Chandra Vidyasagar	*Shri S. K. Bose*	2.00
27.	Surdas (*Hindi*)	*Shri Vrajeshwar Varma*	1.75